DISSERTATION

RAND

Italy's All-Volunteer Army

An Analytical Framework for Understanding the Key Policy Issues and Choices During the Transition

Michele Zanini

RAND Graduate School

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This document was prepared as a dissertation in September 2001 in partial fulfillment of the requirements of the doctoral degree in policy analysis at the RAND Graduate School of Policy Studies. The faculty committee that supervised and approved the dissertation consisted of Harry Thie (Chair), Stuart Johnson, and Richard Hillestad.

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PREFACE

The Italian Army is in the midst of a transformation process toward an All-Volunteer Force (AVF). The research reported here builds an analytical framework for understanding the key policy issues and tradeoffs affecting such a transition. The analysis specifically focuses on the management of the enlisted and non-commissioned officer (NCO) force.

This effort depended considerably on the gathering of official policy guidance and personnel management data, which was in large part obtained with the assistance of the Italian Army General Staff. The data collection effort began in the Spring of 1999, and ended in January 2001. This implies that the following discussion does not explicitly take into account the laws and regulations adopted in 2001 (and most importantly Legislative Decree 82/2001, which modifies the promotion path of career soldiers as well as the steady-state targets for NCOs). However, the basic findings of this dissertation have not been overtaken by events--the Italian Army will continue to face the challenges that stem from a very senior target force mix and the considerable length of military careers. Moreover, the recent revisions made to the system do not address the shortfalls the Army is currently experiencing in its recruitment and career personnel management processes.

This research should be of interest to policy-makers who wish to learn more about the future structure and capabilities of the Italian military, and/or to explore some the policy implications of transforming a military to an All-Volunteer Force. The dissertation work was in part supported by RAND's National Defense Research Institute, a federally funded research and development center sponsored by the Office of the Secretary of Defense, U.S. Department of Defense. It was completed in partial fulfillment of the requirements of the RAND Graduate School for the degree of Doctor of Philosophy in Policy Analysis.

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SUMMARY

S.1 SCOPE AND PURPOSE

This dissertation builds an analytical framework for understanding the key policy issues and tradeoffs affecting the Italian Army's transition from a mixed conscript/volunteer model to an All-Volunteer Force (AVF). The analysis specifically focuses on the management of the enlisted and non-commissioned officer (NCO) force, and is driven by two specific research goals:

- assist the Army in identifying transition paths most likely to lead to a balanced force, taking costs into account, where the "balanced force" objective is related to how personnel are distributed by grade and years of service (YOS);
- provide guidance on force management processes such as recruitment and identify areas for improvement.

These objectives were pursued in two distinct phases. In the first phase a significant quantity of information was gathered on the Army's personnel systems and processes--including the recruitment establishment, compensation and promotion, and the current experience mix. Data were collected during a series of interviews and visits with Army and Ministry of Defense (MoD) officials. These were then combined with insights from the existing military manpower literature to generate hypotheses and preliminary conclusions.

A host of these hypotheses were then tested in Phase 2, which focused on modeling the Army's transition to an AVF. The second stage of research revolved around a simulation model of Army personnel dynamics, which tracks over the next three decades system behavior (e.g., size, grade and YOS distribution, exits, promotions) as a function of different policy assumptions and interventions. The model is used to identify alternative strategies designed to improve outcomes, which are then evaluated using a multi-attribute utility methodology. Using a multi-attribute approach recognizes that there are numerous

factors that contribute to the notion of force "balance." Performance is tracked for multiple measures of effectiveness and costs; strategies are then ranked on the basis of their aggregate cost and effectiveness. The performance of a given alternative is ultimately judged on its robustness across a different set of assumptions of how much policy makers would value an outcome measure (or set of measures) over the rest.

S.2 FINDINGS

The simulation results indicate that *implementing the Army transition plan--and the current Army long-term manpower mix targets--is likely to lead to an unbalanced force.* The principal drivers of personnel imbalances include: (1) persistent concentrations of soldiers in a small number of years of service; (2) an overly senior career force in the medium-to-long-term; (3) extended stays in terminal grades; and (4) irregular promotion tempo.

In turn, these imbalances could create personnel management difficulties as well as age/skill mismatches that could ultimately affect force readiness. These potential problems are not being recognized explicitly today, in large part because the system is not displaying the full spectrum of stresses and shortfalls that will emerge over time. Importantly, all the existing problems and shortfalls are greatly amplified by:

- the considerable length of military careers, and
- the Army's steady-state targets, which lock the system into a very senior personnel mix.

The analysis also points to shortfalls in three critical personnel management areas:

- the Army is taking a passive attitude toward recruitment, and its efforts are hampered by a series of bureaucratic problems;
- personnel policy is rendered less effective by lack of differentiation among prospective recruits and active-duty personnel—this trend is especially evident in the Army's compensation and promotion systems;

- in turn, such lack of differentiation is directly related to the paucity of systematic and reliable data on how soldiers respond to different incentives at the point of recruitment and beyond.

S.3 POLICY RECCOMENDATIONS

Italian Army planners should consider a number of recommendations as they plan the transformation to an All-Volunteer Force. Some are directly related to the modeling results, while others are essentially suggestions for improving the current personnel management processes.

Modeling-related recommendations

The Italian Army faces a fundamental choice: it could either (1) seek the best solution under the current target steady-state mix, or (2) contemplate other potential steady-states.

- *If the Army wishes to continue with the current set of long-term force targets, then it will have to rely on an early separation program to reduce effective career lengths.*

Such program needs to be implemented gradually in order to reduce the swings in demand of personnel caused by the eventual exits of large concentrations of personnel currently in the force, especially in the career enlisted and Sergeant grades. This is by far the policy measure with the greatest amount of leverage. Policy interventions that leave the system's basic properties unchanged--such as variations in promotion timing and percentages quotas between personnel categories--*cannot by themselves prevent the significant imbalances that would occur without early separations.*

- *The relatively narrow range of feasible outcomes arising from the model-based analysis indicates that the Army should explore the possibility of moving toward more junior steady-state force mixes.*

This dissertation does not seek to offer guidance on how the Army should decide between steady states; indeed, answering the question of what

long-term force mix the Army should pursue is a full-fledged research endeavor in its own right. On the other hand, the findings reported here suggest that greater "out of the box" thinking is warranted, especially since more junior steady-states could well be cheaper, more flexible and more effective in the long run.

Personnel management recommendations

Long-term manpower planning decisions can be greatly facilitated by improving the current personnel management processes, and making them more attuned to the post-conscription era. In particular, the Army should:

- *First, make the recruitment process more proactive and applicant-friendly.*

Many of the problems that hinder Italy's transition to an sustainable AVF are directly related to the fact that potential supply of enlistments is not being successfully converted into actual supply. Given the cost-effectiveness of military recruiters in the U.S. context, the Army should explore how this tool might work in Italy. One of the options to be considered would entail the establishment of a dedicated group of individuals who are responsible (and rewarded) for encouraging enlistments. In addition, the high attrition rates hampering the effectiveness of the current screening process could be reversed with an "applicant-friendly" approach, whereby tests and examinations administered more frequently and closer to the homes of prospective recruits. More broadly, the Army needs to undertake a comprehensive policy review of the recruiting process, including analyses of such areas as propensity to enlist and how it varies by demographic characteristics.

- *Second, adopt a more sophisticated approach to personnel management.*

The Italian Army has yet to fully adapt its systems to take into account the fact personnel with varying skills, quality levels, and experience have to be managed and compensated in a differentiated fashion. As past research in the field of military personnel has

demonstrated, individual characteristics such as quality and occupational skills play a large role in determining overall productivity--and cost. To gain a better understanding of how these traits affect military labor supply, the Army is advised to invest in further research and experimentation. With more and better information in hand, the Italian Army will be able to adopt a more comprehensive approach to the promotion and compensation of military personnel. For instance, special bonuses could be given to those willing to sign up for a hard-to-fill occupational specialty; recruitment goals could be based on quality-focused quotas; and compensation for individuals in terminal grades could at least in part be performance-related. A differentiated approach would also require a greater bureaucratic capacity to collect and interpret a richer set of data on soldiers, their skills, and their behavior. Such data would also have to be used to construct equally detailed manpower plans by quality, experience mix, and occupational group. Finally, this approach would need to be extended to evaluation systems and the management of eventual early separations.

S.4 RESEARCH AND POLICY CHALLENGES FOR THE FUTURE

This dissertation serves as a preliminary study of the issues and dilemmas that will confront the Italian Army as it transitions to a smaller, all-volunteer force. To be sure, much needs to be better understood before being able to make increasingly specific recommendations. Two principal tracks for further investigation appear most relevant: (1) studies on alternative steady-state force mixes, and (2) experimental/econometric analyses of soldier behavior and its determinants (especially recruitment). These two avenues are tightly related--for instance, finding ways to solve recruitment problems by means other than relying on a very senior steady-state force mix will make any consideration of alternative force mixes more plausible.

Perhaps the most fundamental finding from this research is that the Army cannot be successful in managing the transition with the policies and processes it currently has in place. It is equally clear that the system has to be changed in substantial ways in order to bring performance to acceptable level. Identifying additional areas for

improvement, and the policy interventions that can bring an effective transformation, will remain a critical research need for years to come.

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Most importantly, I would like to thank my mother and father, Clara and Luigi Zanini, for the unconditional support, encouragement, and love they have given me throughout my academic career, so far away from home.

Any errors remaining in the text are my sole responsibility.

INTRODUCTION

No event in recent memory has the potential to transform the Italian military more than Defense Minister Carlo Scognamilgio's legislative bill to end conscription, first presented to Parliament in 1999. This document, which was eventually passed by Congress in late 2000, calls for a fully volunteer force by the end of 2006, and a significant decline in the overall size from 280,000 to 190,000 soldiers. Out of the three military services, the Army is facing the most daunting challenges. It has historically relied on conscripts to a far larger extent than the Air Force and Navy. The planned elimination of draftees in five years implies that while its overall size will decrease (from roughly 180,000 to 112,000), the share of volunteers will have to increase dramatically. Steering the force through these changes presents a series of challenges that, if not met, could undermine the overall effectiveness of the Italian military.

I.1 RESEARCH OBJECTIVES AND APPROACH

The dissertation builds an analytical framework for understanding the key policy issues and tradeoffs affecting the Italian Army's transition from a mixed conscript/volunteer model to an All-Volunteer Force. The analysis specifically focuses on the management of the enlisted and non-commissioned officer (NCO) force, and is driven by two specific research goals:

- assist the Army in identifying transition paths most likely to lead to a balanced force, taking costs into account, where the "balanced force" objective is related to how personnel are distributed by grade and YOS;
- provide guidance on force management processes such as recruitment and identify areas for improvement.

These objectives were pursued in two distinct phases. In the first phase a significant quantity of information was gathered on the Army's personnel systems and processes--including the recruitment establishment, compensation and promotion, and the current experience

mix. Data were collected during a series of interviews and visits with Army and Ministry of Defense (MoD) officials. These were then combined with insights from the existing military manpower literature to generate hypotheses and preliminary conclusions.

A host of these hypotheses were then tested in Phase 2, which focused on modeling the Army's transition to an AVF. The second stage of research revolved around a simulation model of Army personnel dynamics, which tracks over the next three decades system behavior (e.g., size, grade and YOS distribution, exits, promotions) as a function of different policy assumptions and interventions. The model is used to identify alternative strategies designed to improve outcomes, which are then evaluated using a multi-attribute utility (scorecard) methodology. Using a multi-attribute approach recognizes that there are numerous factors that contribute to the notion of force "balance." Performance is tracked for multiple measures of effectiveness and costs; strategies are then ranked on the basis of their aggregate cost and effectiveness. The performance of a given alternative is ultimately judged on its robustness across a different set of assumptions of how much policy makers would value an outcome measure (or set of measures) over the rest.

I.2 OUTLINE OF NEXT CHAPTERS

This dissertation is divided into two main parts, reflecting the research sequence mentioned above. *Part 1* lays out in four chapters the issues to be addressed, and considers past work in this area. Its contents include an in-depth examination of the key manpower policy areas such as enlistment, career force management, and force mix. The discussion of each major issue is accompanied by a literature review, an account of the Italian Army experience and plans in this area, and the identification of critical policy issues. After introducing the policy context and problem in Chapter 1, supply-side considerations are covered in Chapters 2 and 3.[1] Chapter 2 is devoted to the enlistment process; the discussion here will focus on how the enlistment decision is

[1] The discussion of supply-side issues precedes that of demand-side requirements because they are currently the most salient in the Italian AVF debate, and possibly the least explored.

affected by a set of policy levers including compensation, human capital development incentives, and the structure and strategies of the recruiting establishment. Chapter 3 instead focuses on personnel that has gone beyond the enlistment decision, examining the impact that compensation and promotion policies have on their choices.

The discussion of demand-side factors is equally important; in fact, Army supply-side efforts should be complemented with initiatives focusing on how the Service's demand could be modified to meet the AVF objectives. Demand-side considerations are covered in Chapter 4 and they primarily focus on the tradeoffs and impact that different quality, grade and experience mixes have on the productivity and costs of the force.

The model-based policy analysis is the focus of *Part 2*. Chapter 5 provides a discussion of the methodological approach that underpins the modeling phase of the study by specifying the relevant policy objectives and criteria used to evaluate outcomes. These draw upon the data and insights presented in the previous four chapters. The model itself is introduced in Chapter 6 by covering its basic features, the principal modeling challenges, and the steps that were taken to ensure its validity, verifiability, and accreditation. Chapter 7 begins the exploration of results with more detail on the policy levers that were manipulated during the simulation; running the model with each of these levers on its default setting produced a baseline scenario, which presents a "best guess" of how the system is likely to evolve over time. The exploration of policy interventions and alternative transition paths is instead covered in Chapter 8, which also explains how these were identified, and how results were evaluated and compared.

Finally, Chapter 9 summarizes the principal policy implications of the research, as well as the conclusions that can be drawn from these. It focuses both on the outcomes from the modeling phase as well as on the insights obtained from the examination of the current personnel management processes in the earlier chapters. The last section concludes with suggested avenues for future research.

PART 1. BACKGROUND AND RELEVANT POLICY ISSUES

1. THE POLICY CONTEXT AND PROBLEM

This chapter provides some context on (1) the reasons why Italy decided to end conscription,[2] (2) the government transition plans for the armed forces in general and the Army in particular, and (3) the most salient issues confronting Italian Army planners as they seek to meet the goals set in such plans.

1.1 THE DECISION TO END THE DRAFT

Several factors have prompted the Italian government to end the draft. As discussed below, strategic, operational and domestic considerations were all critical in weakening the usefulness and acceptability of the draft, both as a method for military manpower procurement and as a social institution.

Strategic considerations

The changes to the strategic environment around Italy since the end of the Cold War have provided a renewed impetus for restructuring the country's military establishment. The demise of the Soviet Union largely mooted NATO's in-depth territorial defense doctrine, and therefore Italy's traditional reliance on large numbers of conscripts. Few planners believe that the country's territorial integrity is threatened by potential attacks, especially strikes carried out by ground forces.

At the same time, however, geopolitical shifts in Italy's southern and eastern peripheries have triggered a set of new security challenges. Instability and local conflicts in adjacent regions--such as renewed conflict in the Balkans, or the rise of a North African regime hostile to Western interests--could have a profound impact on Italian national interests.[3] Such challenges can be best addressed by an active Italian

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[2] The AVF law does not abolish the draft; it actually suspends it until further notice. This wording was necessary in order to avoid amending the constitution, which enshrines the concept of universal military service.

[3] When describing the security challenges facing Italy, policy makers usually refer to the presence of two arcs of crisis: one that

role in preventive diplomacy and crisis management, underwritten by robust power projection capabilities. Thus, Italy now conceives its national security less in terms of the defense of territory and more as the defense of interests that often require actions outside of national borders.

Operational considerations

Italian planners have also realized that, from an operational standpoint, the need for improved power projection capabilities can best be met through a greater use of professional personnel. Italy's numerous post-Cold War missions overseas, including Somalia, Bosnia, Albania, and Kosovo, have underscored the need to acquire the capabilities for quick and repeated troop deployments beyond national borders.[4] Moreover, operations such as the ones in Bosnia and Kosovo are complex, requiring a level of skill and training that cannot be imparted in—and utilized within—10 month's worth of military service. These operations also take place in potentially hostile conditions, making the deployments of conscripts politically unpalatable.

The fact that other NATO allies such as France, Spain and the Netherlands have fully embraced the notion of a fully-volunteer Army and are already transitioning toward that model has put further pressure on Italy to follow suit. Since future Italian deployments will likely take place in a coalition context, military planners in Rome have concluded that operating alongside volunteer forces from allied countries requires a similar level of professionalism and skill.

Domestic considerations

Perhaps the most immediately important factor behind the decision to adopt an AVF was the weakened sustainability and legitimacy of the draft as a social institution. During the 1990s, a series of developments called into question the very premises on which the system of conscription was based. These include the increase in popularity of

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runs from the Baltic through the Balkans and into the Caucasus, and another through North Africa, across the Middle East and into the Persian Gulf. See Kemp (1996).

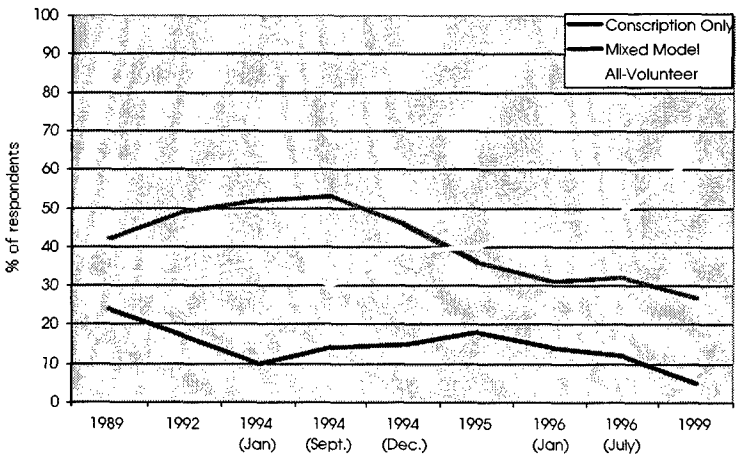
[4] As of September 2000, Italy had 8,145 soldiers deployed overseas, 7,910 of which are stationed in Bosnia, Albania, FYROM and Kosovo (Italian Ministry of Defense, 2000).

an all-volunteer force among the public, the swift increase of individuals opting out of military service, the steady decline in the size of military-age male cohorts, and the lack of social representativeness of military service.

Increase in popularity of volunteer forces

The weakening of conscription's strategic and military rationale has been matched by a decrease of its popularity among the Italian public. According to a series of periodic surveys tracking changes in public opinion on military matters (Difebarometro), the option of maintaining the draft to support a mixed/conscript Army has steadily declined since the mid-1990s (see Figure 1.1). The all-volunteer military has instead grown steadily in popularity, with two-thirds of the respondents claiming this would be their preferred system in 1999. In the same year, only 5% of the respondents indicated a fully conscripted Army as the most desirable military manpower model.

Figure 1.1 Support for alternative approaches to military manpower procurement



source: Difebarometro

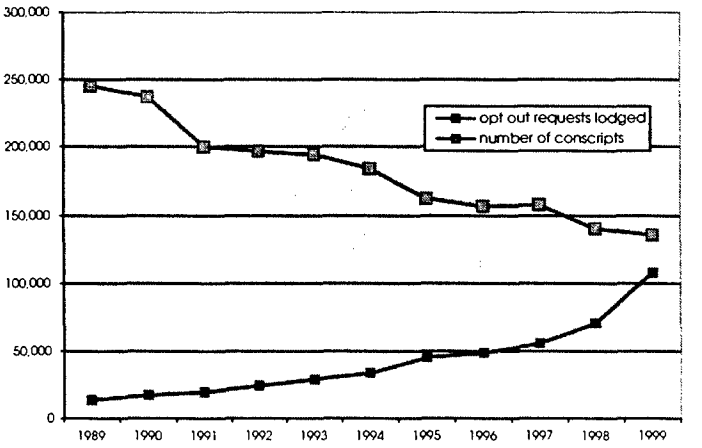
To be sure, the government's decision in late 1998 to consider suspending or eliminating the draft played a role in shaping public opinion. At the same time, however, the marked shift in favor of an all-volunteer force was in large part caused by the realization by most Italians that the draft had become unnecessary, unsustainable, and less legitimate.

Increased opting out

One of the key factors that has significantly impaired the viability and legitimacy of conscription has been the steady increase in the number of individuals of military age who decline to spend the mandatory 10 months in barracks, and instead decide to dedicate an equal amount of time to what is called "civilian" service--working for an approved non-governmental organization or a local government body.

As shown in Figure 1.2, applications to opt out of military service began to mount dramatically in the mid-1990s, when the duration of civilian service was shortened to match the length of military service.[5] Faced with a choice between working for organizations such as the Red Cross in one's city and the rigors of military life, Italian youth began what turned out to be a mass migration away from military service (Figure 1.2).

Figure 1.2 Number of conscripts vs. opt out requests lodged, 1989-1999



source: Italian Ministry of Defense (MoD) and International Institute for Strategic Studies (IISS)

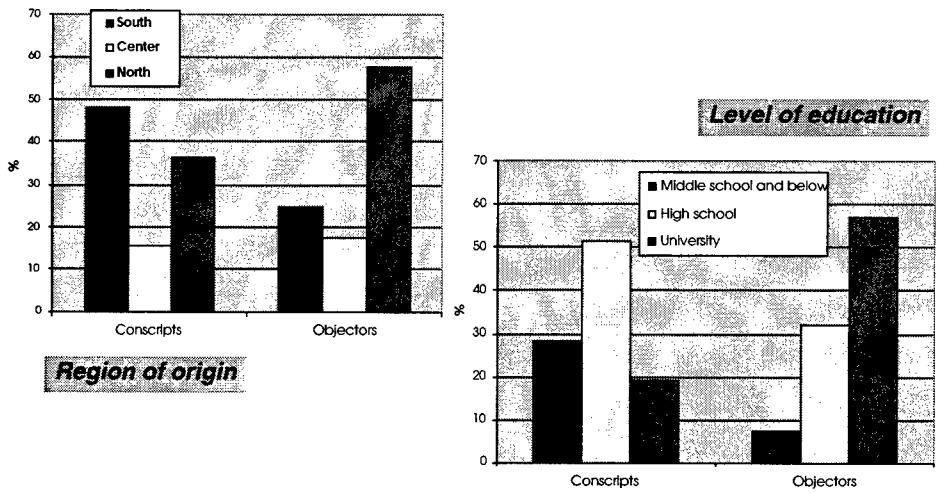
Such migration was given a further boost by a 1999 law which greatly facilitated the complete exoneration from service by individuals whose applications for civilian service are accepted (Battistelli, 2000). This provision was certainly a factor behind the large increase in applications lodged in 1999, when they almost matched the number of conscripts actually serving in the military.

[5] The vast majority of lodged applications have traditionally been accepted, albeit with some considerable delay in a number of cases.

Decreasing social representativeness

The likely prospect that in the near future there would be more individuals in civilian rather than military service seriously concerned even the most ardent supporters of the draft within the Ministry of Defense. Equally importantly, the increased popularity of civilian service helped to further weaken the draft as an institution, whose legitimacy is obtained from the notion of universal military service. In fact, the military also had to face increasingly strident criticisms that its conscription system was (and still is) falling short of its basic representativeness goal. As Figure 1.3 shows, the distribution of military conscripts by region of origin and level of education are skewed toward over-representation of lower-educated, and Southern, Italian youth.

Figure 1.3 Conscripts and objectors by region of origin and education level



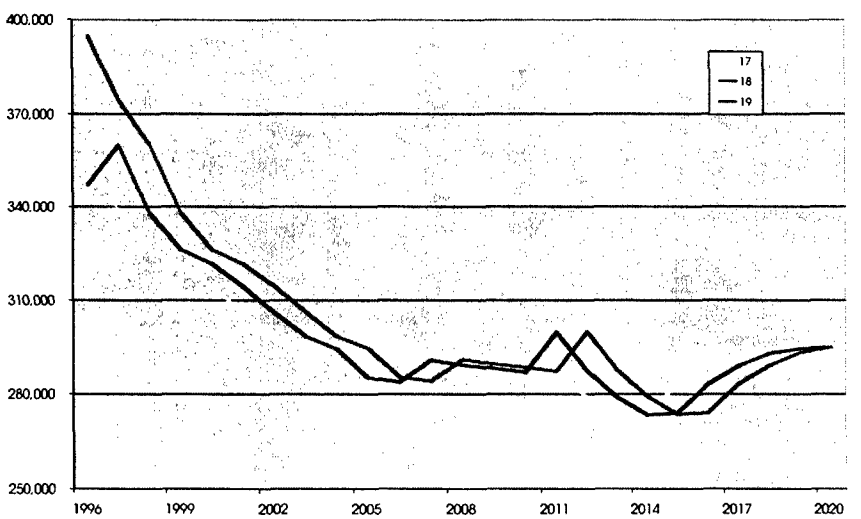
source: Battistelli (2000)

Those who manage to opt out are mostly well-educated Northerners, who can rely on a large local pool of certified NGOs and local government bodies willing to employ them for 10 months (Northern youth as a whole make up a third of the military-age cohort). Less educated Southerners instead form the bulk of the conscript military, in part because the South lacks a vibrant NGO community. In fact, three-fourths of the certified NGOs in which young men can serve are located in Northern and Central Italy (Battistelli, 2000).

Demographic factors

To make matters worse, the pool of potential conscripts is destined to shrink as a result of an imminent decline in military-age male population. This demographic trend started in the early 1990s, and is projected to reach its minimum in 2014, according to a "middle of the road" population growth scenario prepared by the Italian Statistics Institute (ISTAT). The decline is even more significant for the 20-to-24-year old cohort (not shown in Figure 1.4), since it still has to experience the "valley" in the age distribution created by today's smaller 17-to-19-year old cohort. By 2011, there are forecasted to be 1.45 million Italian males between the ages of 20 to 24, compared to 2.22 million in 1996.

Figure 1.4 Projections for selected military-age youth cohorts



source: Italian Statistics Institute (ISTAT)

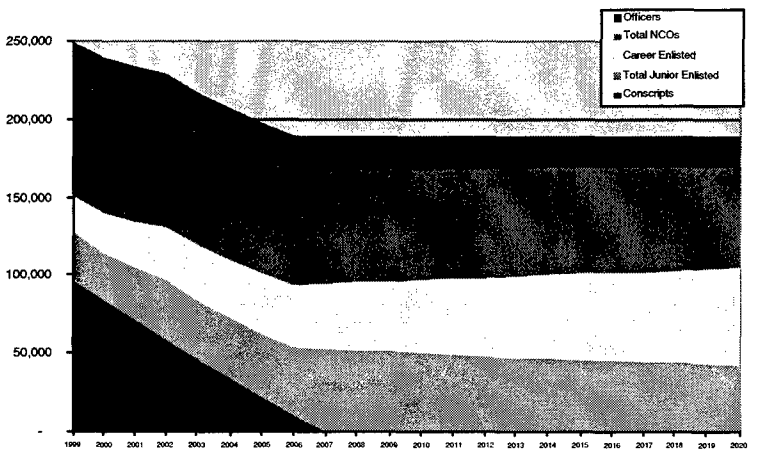
Italian military planners had to some extent been preparing for a reduction of conscripts in the force--both in absolute terms and relative to volunteers. In fact, Italy's New Defense Model (a 1995 white paper issued by the Joint Chiefs) called for, among other things, a gradual reduction of conscripts to 72,000 by 2005, out of a total reduced force of 250,000 (Italian Joint Staff, 1995). However, the combination of several adverse trends, as well as the decision taken in the mid-1990s to reduce a conscript's tour from 12 to 10 months (which effectively decreased the total man-hours available from each cohort by

16%), put in jeopardy even the most modest numerical aspirations for the draft.

1.2 THE NEW FORCE AND TRANSITION PLANS

The factors mentioned above prompted Italy's government to suspend the draft, and to move from a mixed conscript/professional force of about 280,000 to one that is significantly smaller (190,000) and made up exclusively of professionals. The government plan calls for a gradual reduction in the number of conscripts until this category is eliminated at the end of 2006. At that point the military will have reached its 190,000 ceiling, although the steady-state composition of the force will not be attained until 2020 (Italian Senate, 2000). The transition period extends over two decades because there is only a small amount of career volunteers currently in service: this personnel category can only be expanded after a larger number of junior volunteers is recruited and progresses through the ranks. Such time delay implies that the military will have to wait until 2007 before it can sense any significant increase in the number of career volunteers, as shown in Figure 1.5. As the number of career enlisted volunteers increases, the stock of NCOs is projected to decrease.

Figure 1.5 The overall transition plan up to 2020



source: Ministry of Defense

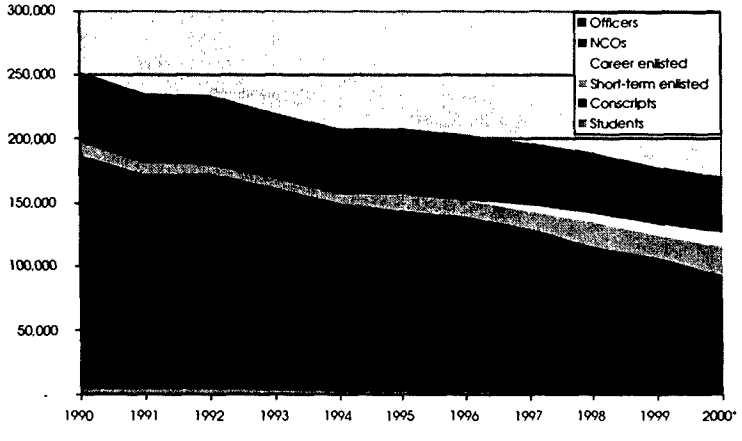
The steady-state force will be composed of 42,000 junior enlisted soldiers (22% of the force); 62,500 career enlisted soldiers (33%); 65,000 NCOs (34%); and 20,500 officers (11%). What is abundantly clear

from such plans is that the steady-state force will be much more senior than today's. According to the cost projections contained in the AVF law, the financial burdens of the transition are likely to be small. Doing away with conscripts gives no financial leverage, since draftees have always been paid well below the economic value of their services (Cooper, 1977). But the increases in the costs associated with a more senior enlisted force (given the increase in career enlisted personnel) will be offset, according to plans, by a reduction in higher-paid NCOs.[6]

Army plans

As mentioned above, much of the recent changes to the Italian military manpower structure were guided by the armed forces' efforts to transition toward a "New Defense Model." In accordance with such plans, the Army has been gradually decreasing its reliance on conscripts, and instead began to expand its intake of junior as well as career enlisted volunteers (Figure 1.6).

Figure 1.6 Evolution of the Army's personnel mix, 1990-2000



source: based on Army General Staff data

The introduction of an all-volunteer force will prompt another significant change in the planned personnel mix for the Army. In all likelihood, the total size of the ground forces will be of about 112,000 soldiers, or 60% of the entire AVF.[7] In the new steady-state, there

[6] The costs considered here are *average* costs per soldier, and are based on the projections contained in the AVF law.

[7] As of January 2001, the precise Army force mix was still the subject of discussion within the Ministry of Defense. The numbers

should be approximately 12,000 officers, 25,000 NCOs, and 75,000 enlisted soldiers (most of whom would be career enlisted). This in stark contrast to the today's force, as well as to the old steady-state force (Table 1.1). While its size will be much smaller, the number of enlisted volunteers will have to almost triple to meet the planned steady-state requirements, while the number of Marshals—the senior NCO category—will instead have to shrink by approximately 12,000 (45%) to 15,000.[8]

Table 1.1 The new (estimated) Army steady-state personnel structure compared to the previous one and the situation in 1999

	1999	Old steady-state	New steady-state
Officers	17,651	11,350	12,000
NCOs	29,536	28,400	25,000
Marshals	27,341	17,700	15,000
Sergeants	2,195	10,700	10,000
Enlisted volunteers	25,452	39,722	75,000
Career	8,520	16,722	45,000
Junior	16,932	23,000	30,000
Conscripts	104,628	70,528	-
Grand Total	177,267	150,000	112,000

source: Ministry of Defense

1.3 TRANSITION ISSUES

The drastic changes facing the Army have prompted several observers to question whether the transition to an AVF will be successful and sustainable. Some, like former Defense Minister Andreatta, doubt whether a sufficient number of qualified volunteers can be recruited and retained.[9] The eventual costs of a transformation to a professional force in a very budget-constrained environment have also caused concern among various observers and analysts (Galluzzo, 1999). Others, including several military planners at the Army General Staff, worry about the adequacy of the current policy framework in the long run. Given that personnel stocks for the career enlisted soldiers have

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reported here represent the best guess of Army planners at that particular time.

[8] The personnel categories and the rank structure within each will be discussed in detail in Chapter 3.

[9] "Ma Adesso Bisognera' Aspettare che la Finanziaria Reperisca i Fondi," *Il Messaggero*, September 9, 1999.

only recently began to fill, and that a military career will on average be of 37 years, the system could prove to be increasingly unsuitable over time.[10] Questions about the Army's own manpower requirements have also emerged—what types of individuals does the service needs? Even assuming that all plans are geared toward a steady-state to be achieved by 2020, what types of force mixes (especially in terms of years-of-service and grade distribution) and policies should be considered to ensure a given amount of "balance" and readiness over the course of the transition? The following chapters begin to address these critical issues.

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[10] Thirty-seven years of service represent an estimate of the *actual* length of a career from 2008 and beyond. This differs from today's *actual* length of approximately 34 years, and the career length counted for retirement purposes. In fact, the *administrative* YOS count is typically three years greater by the end of one's career since individuals can "gain" years of service while on operational assignments. Such a gain implies that until 2007 the *administrative* maximum retirement YOS is approximately 37; from 2008 onwards it will become 40. See Chapter 3 for more detail.

2. ENLISTMENT AND RECRUITMENT

This chapter provides a close look at the enlistment and recruitment decision. It first reviews the policy approaches adopted in other militaries (primarily the U.S.), as well as the estimates of their effectiveness. This is followed by a description of the main features of the Italian recruiting system and its performance in recent years.

2.1 THEORY AND FINDINGS FROM PAST RESEARCH[11]

Recruitment policy tools

A large body of literature on the enlistment decision in an all-volunteer environment has been developed mainly in the United States since the 1970s. From this analysis, two critical policy levers emerge:

- Compensation (wages and non-monetary benefits including human capital incentives);
- The structure and operation of the recruiting establishment.

1. Compensation

Asch (1993, p.14) defined compensation as "the sum of pecuniary (cash) benefits and the value to the individual of nonpecuniary benefits." Asch's work on the relationship between compensation and the enlistment decision was based on Rosen's 1992 occupational choice theory model,[12] which assumes that the economy is formed by a civilian and military sector. Prospective recruits consider the monetary and non-monetary advantages of each sector. Enlistment occurs when the difference between military and civilian wages is greater than an individuals' net preference for civilian life.[13] Part of the recruiting

[11] A large portion of section 2.1 is based on studies first summarized by Warner and Asch (1995).

[12] Originally cited in Warner and Asch (1995, p. 352).

[13] Other things equal, an individual may prefer civilian life because of the hardship and discipline associated with a military career. Having said that, a military position can bring significant nonpecuniary benefits, including "pride of service to one's country, the opportunity for travel, and possibly a more stable employment" (Warner and Asch, 1995, p.352).

challenge for the Army, therefore, is to devise the right set of incentives that induce a sufficient number of able individuals to prefer military to civilian life. To be sure, military pay can be changed in order to affect enlistments across the board. But other incentives are targeted to particular sets of soldiers, and are linked to notions of "human capital."[14] One could posit that the more transferable the skill set learned on the military job, the greater will be individual propensity to join. It therefore follows that the military may need to provide greater inducements to those who are unlikely to acquire much transferable human capital, perhaps because of their assignment to low-skilled tasks. The enlistment bonus program in the U.S. is based on this premise, since it is designed to encourage individuals to join in those "critical" skill specialties that are less transferable, such as combat arms (Kirby and Thie, 1996, p.131). Educational benefits provide another human capital development incentive in the United States, and like the enlistment bonus program they are only offered to those enlisting in particular skill areas.

2. Recruiting establishment

Research in the field of military labor supply points to the importance of other factors shaping the enlistment decision—including the military's own recruitment efforts. In fact, the military has a number of recruitment levers that can be manipulated to stimulate supply, including advertising and other promotional activities. In countries such as United States, the use of recruiters also constitutes a critical policy tool. Recruiters are typically deployed in particular geographical areas; they are evaluated on their ability to meet quotas based on the personal characteristics of prospective enlistees (e.g. quality and gender). To stimulate recruiter productivity, a number of incentives have been devised, including improved promotion chances and official commendations for good performance (Oken and Asch, 1997).[15]

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[14] The concept of human capital and its impact on force productivity is also considered in Chapter 4.

[15] As mentioned below, recruiter management is critical in determining the types of individuals who ultimately enlist because recruiter behavior is highly sensitive to quotas and incentive plan structure.

The programs implemented by the recruitment establishment can also help shape society's views on military service. They can target individuals who play an "influencer" role in a youth's decision to enlist. In fact, research by Orvis et al. (1996) has demonstrated that enlistment choices are significantly affected by such factors as the advice of family and friends and the public image of the military as an institution.

Empirical models of manpower supply

A host of econometric models have been developed to examine the effects of the policy levers mentioned above, controlling for exogenous factors such as unemployment. Such studies make an explicit distinction between low and high quality enlistment—a concept that is briefly introduced below.[16]

The impact of quality on enlistment decisions

Enlistment models that differentiate between low- and high-quality soldiers assume that the supply of high-quality soldiers is upward-sloping—that is, all other things being equal, increasing enlistments by moving along the supply curve will imply an increase in the factor that determines the supply—such as wages, bonuses, recruiters, and educational benefits (see supply curve S_{HQ} in Figure 2.1, which maps supply as a function of wages). This implies that high-quality recruits are supply constrained—that is, there are fewer high-quality individuals than low-quality individuals relative to the Army's total demand, and therefore the Army has to increase pay in order to recruit an extra high-quality soldier.

In contrast, one could assume that at the extreme the supply of low-quality soldiers is *perfectly elastic*—or flat (S_{LQ})—meaning that the Army could recruit as many of these soldiers as it wished without an increase in recruiting resources (e.g., it could still offer the going wage, or maintain the same number of recruiters).[17] Again, this has to

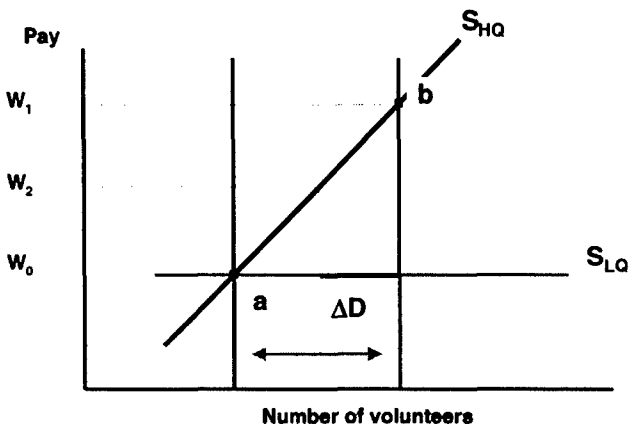
[16] The U.S. services emphasize the recruitment of "high quality" youth, defined as high-school degree graduates who score in the upper half of the Armed Forces Qualification Test (AFQT) score distribution.

[17] Supply elasticity is a measure of the responsiveness of supply to various factors, such as wages. It is defined as the percentage change in quantity supplied relative to a given percentage change in the

do with the relatively large number of low-quality individuals compared to the quantity the Army would like to hire.

As Figure 2.1 shows, in extreme cases and holding every other factor constant, a given numerical increase in recruits (ΔD) can be obtained at the going wage (W_0) by drawing exclusively from the low-quality pool, or at W_1 by relying entirely from the high-quality pool. At wage W_2, the Army could meet its increased volunteer goals with a mix of high- and low-quality recruits.

Figure 2.1 Low- and High-quality supply curves as functions of wages



Methodology and estimates

Studies on enlistment supply over the last three decades span two generations (Warner and Asch, 1995, p. 355). First-generation frameworks did not explicitly factor in recruiter behavior as a determinant of enlistment.[18] Second-generation studies such as those undertaken by Dertouzos (1985), Daula and Smith (1985), Polich, Dertouzos and Press (1986), and Bernes and Paula (1993) instead held recruiter effort constant (Appendix A explores in detail the methodological differences between these models).

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factor in question. The wage elasticity of supply can be formally expressed as: $\epsilon^{s}_{x0} = \frac{dx}{dp_x}\frac{p_x}{x}$ where p_x is the wage and x is the amount of labor supplied. An inelastic supply implies that the percentage change in labor supplied is less than the percentage change in the wage.

[18] See, for instance, Goldberg (1981), Asch, Udis and McNown (1983), Dale and Gilroy (1985), Brown (1985) and Nelson (1986). Originally cited in Warner and Asch (1995).

All past research confirms the importance of pay and unemployment as determinants of enlistments; more recent studies estimated relative pay (the ratio of civilian to military wages) elasticity as centering around 0.5 to 1.0 (see Table 2.1 below). *In other words, on average a 10% pay increase relative to civilian wages would bring about a 5 to 10% increase in the supply of high-quality recruits.* Table 2.1 also highlights the fact the number of recruiters has a large effect on the number of high-quality enlistments, with elasticity estimates of around 0.5. National advertising instead has smaller elasticities, at around 0.05 to 0.10 (Dertouzos, 1989, and Polich et al., 1986).[19]

Of the human-capital related incentives, educational benefits are more successful in inducing high-quality enlistments than enlistment bonuses. The establishment of the U.S. Army College Fund in 1982 led to a 9% increase in high-quality enlistments, while enlistment bonuses in the mid-1980s boosted entries of high-quality soldiers by about 5%.[20] At the same time, however, it appears that enlistment bonuses may be superior at stimulating enlistment in particularly critical (and difficult-to-fill) skill areas (Warner and Asch, 1995, pp. 357-358).

Reliable estimates of supply elasticities from other countries are rare. One of the most interesting comparative studies was undertaken by Withers (1978), who estimated enlistment supply for the U.K., Canada, Australia, and the U.S. using data from 1967 to 1973. However, viable estimates could only be calculated for the U.K., since the relatively short time horizon of the analysis and multicollinearity rendered the remaining data less useful. In the case of the British Army, pay and unemployment elasticities were estimated at 1.46 and 0.90, respectively.

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[19] On the other hand, Polich et al. (1986) discovered that the benefits of advertising persist even after the end of a particular campaign. Originally cited in Warner and Asch (1995) p. 357.

[20] These estimates were obtained through experimentation. The effect of educational benefits on high-quality enlistments was gauged through the Educational Assistance Test Program (EATP), conducted in 1980 and 1981 (Fernadez, 1992). The Enlistment Bonus Test (EBT) was instead run from 1982 to 1984 to identify how such enlistment would vary according to different bonus structures (Polich, Dertouzos, and Press, 1986). Both experiments were conducted on a national scale and included control groups. Originally cited in Warner and Asch, 1995, p.357.

Table 2.1 High-quality enlistment supply elasticity estimates (based on Berner and Daula-1993)[21]

	Pay (relative to civilian)	Unemployment	Recruit-ers	Advert-ising	Educat. benefits	Enlistment Bonus	Low-quality enlistments	High-quality goal
Daula and Smith (1985)	0.49	0.56	0.59	0.09	--	--	-0.02 to .11	0.41
Polich, Dertouzos and Press	-0.55[22]	0.94	0.60	0.06	--	--	-0.31	0.22
Goldberg (1991)	1.20	0.59	0.15	0.05	0.14	-0.29	--	--
Kearl, Horne and Gilroy (1990)	0.15-0.62	0.57-0.65	0.48-1.15	0.43-0.72	0.16-0.17	--	--	0.33
Berner and Daula (1993)	0.48	0.49	0.27	0.21	-.04	0.46	--	--

[21] Adapted from Warner and Asch, 1995,p. 358.
[22] Civilian pay only, not relative military to civilian pay.

The cost-effectiveness of recruitment tools

Based on the elasticity estimates reported above, one can compute how recruitment policy levers compare in terms of their marginal cost—that is, how much more would have to be spent for each in order to obtain an additional high-quality recruit.

Table 2.2 Recruitment tools and their marginal cost[23]

Resource	Estimated marginal cost (pay=100)
Entry basic pay	100
Enlistment bonus	53.4
National advertising	23.3
Recruiters	21.0
Educational benefits	19.8

Table 2.2 shows that pay is the least cost-effective resource; this has to do with the fact that increasing pay for the marginal recruit cannot be undertaken without an identical increase for all of those that would have joined at a lower wage. All of the more targeted incentives are significantly less costly at the margin, and advertising, recruiters and educational benefits are clearly most cost effective (when effectiveness in understood in terms of high-quality enlistments).

2.2 ENLISTMENT AND RECRUITMENT: THE ITALIAN EXPERIENCE

This section explores in some detail the enlistment term structure available to those wishing to join the Italian Army and the types of recruitment incentives used to target prospective entrants. It also focuses on the performance of the recruiting establishment since the late 1990s, when the Army began to devote more attention to the recruitment of volunteers.

Enlistment terms

The structure of enlistment terms has changed significantly over the last five years. Prior to 1996, junior enlisted volunteers were recruited from the conscript ranks for renewable two-year stints, but

[23] Table adapted from Warner and Asch (1995), pp. 359-360.

without an explicit career path. Planners realized that recruiting and retaining a large number of volunteers would not be successful unless soldiers are offered significant opportunities for career advancement and development. The government sought to address this requirement by revolutionizing the grade and promotion structure for enlisted soldiers with a legislative decree issued in 1995.[24]

This law specified that junior enlisted volunteers (*Volontari in Ferma Breve;* henceforth referred to as **VFB**) be recruited for three-year terms, with the possibility of two 2-year renewals. At the end of their term, a given number of VFBs are selected to join the career force (promotion is in theory a function of merit). Starting in 2002, VFBs will be recruited for 5-year terms. The Italian Army also allows for the lateral entry as a **Marshal**, a NCO personnel category further discussed in the following chapter. More recently, a new type of volunteer--*Volontario in Ferma Annuale*, henceforth referred to as **VFA**--has also been created. VFAs serve for 12 months and are paid less than VFBs, although they have preferential access to the VFB grades once their term is over. Essentially, these are draft-induced volunteers who decide to enlist for a term 2 months longer than that of conscripts, but benefit from a considerably higher level of pay. The Army relies on VFAs to (1) fill recruitment gaps (primarily shortfalls of conscripts relative to the planned yearly goals), (2) increase the base of potentially deployable troops (although VFAs would not be sent to high-conflict environments), and (3) lure very short-term soldiers into becoming VFBs.

Recruiting process

Recruitment processes for VFBs, Marshals, and VFAs differ markedly. Those wishing to enter service for the 5-year long VFB enlistment term have to be between the ages of 17 to 22. Since 1998 prospective recruits participate in centralized contests administered three times a year. Prior to 1998, the Army had instead been exclusively recruiting individuals through service-specific channels. Army-only recruiting continues, but at a much reduced scale compared to the interservice

[24] *Legislative Decree 196*, May 12, 1995. The promotion system outlined in this law is examined in Chapter 3.

recruiting contests (in 2000 the Army recruited 800 VFBs through its own channels, while in 2001 it plans to recruit an additional 1,200).

The new VFB recruitment process is jointly managed by the three Services, which attempt to coordinate the effort with police forces.[25] Its centralized nature stems from the widely held belief that the armed forces will only attain a sufficient number of enlistments if they offer the prospect of a secure public sector job to those who successfully complete their tour as VFBs. In fact, the non-military institutions involved in the process should in theory commit themselves to selecting a target number of individuals each year and then "loaning" these recruits to the military as VFBs.

For each VFB contest, the three services and other governmental bodies decide on (1) the number of individuals to be recruited for each service, and (2) the ultimate destination of that recruit after his/her term is over.[26] The Army only screens applicants who have indicated their desire to potentially become career enlisted soldiers at the end of the first term. The police forces are instead responsible for the selection of recruits who have chosen these institutions as their preferred future career "homes."

The recruitment process for VFBs begins with a standard application form, which can either be submitted to a local military office or to the Ministry of Defense in Rome. Those deemed eligible to take part in the contest and who sign up for an Army career are then invited to a national test and evaluation facility in Central Italy for an initial screening multiple-choice test. Those who pass such test then undergo a series physical fitness, medical and aptitude tests.

Lateral entry contests for Marshals are instead organized once a year, and eligible individuals have to be between the ages of 17 and

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[25] These include the National Police force, the paramilitary Carabinieri, the Coast Guard, and the Park Service.

[26] For instance, in the third contest of 1999, the Army offered 2,389 VFB slots: out of these, 1,203 were reserved for individuals wishing to become career soldiers in the Army, while the remainder were allocated to applicants who instead declared their interest in leaving the Service after the first term to join institutions such as the state police or the Carabinieri, Italy's paramilitary police force.

26.[27] Unlike VFBs, the Army manages its own Marshals contests since this personnel category has a career-long (approximately 37 years) and service-specific term of enlistment. The recruitment process for Marshals is structurally similar, but more competitive, than the one described for VFBs.

Recruitment for VFAs is instead much less structured--responsibility for screening and enlisting applicants is delegated to the regimental level, and the prerequisites are less strict than those used for VFBs (they are virtually the same as those applied to conscripts). Interestingly, recruitment is managed on a first-come, first-serve basis: each regiment's designated VFA slots are filled according to the order the applications are received. The Army decides how many VFAs need to be recruited on a monthly basis.

The Army's recruitment policy tools

Compensation

VFBs receive approximately 19 million liras (Lit. 19m) each month—after tax, this amounts to approximately Lit. 14.5m.[28] After the first year, there is a 7% increase which brings after-tax pay to approximately Lit. 15.7m. An entry-grade Marshal is paid as much as a VFB for the first two years while he/she is enrolled at the NCO academy.[29] VFAs instead receive slightly less-Lit. 9.6m per year after tax. The Army also provides an exit bonus for all those VFBs who successfully complete their term, amounting to Lit. 9.2m—or about 40% of their yearly salary.

For VFBs, military pay does not appear to be grossly over or under the median of the income distribution for military age youth (Table 2.3).

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[27] Women can be accessed laterally as Marshals until the age of 29.

[28] After-tax income is estimated by subtracting from gross income the taxable amount as specified by the Italian Ministry of Finance's income tax tables, which vary by income brackets (Italian Finance Ministry, 2000). Other taxes and/or exemptions are not included in this rather rough calculation.

[29] The career earnings profile of a laterally-entering Marshal is substantially greater than a VFB, however (see Chapter 3).

Table 2.3 Estimates of the after-tax income distribution for males 17/22 years of age, 1998 (K Lire, adjusted for nominal wage growth)[30]

Decile	After-tax Income: MALES (n=180)	After-tax Income: MALES & FEMALES (n=293)
10	8,176,000	8,176,000
20	10,220,000	10,220,000
30	12,264,000	12,264,000
40	14,716,800	14,308,000
50	16,352,000	15,330,000
60	18,396,000	18,396,000
70	19,418,000	19,418,000
80	21,257,600	20,440,000
90	22,760,962	23,506,000

source: based on Bank of Italy data

The salary of a VFB is roughly between the fortieth percentile and the median of the civilian income distribution at a national level. Military wages are very likely to place even higher in the income distributions of Southern youth, since according to Bank of Italy data the median salary in the South is approximately Lit. 12m; in the North the median wage is instead at around the Lit. 18m mark. Salary for VFAs instead ranks well below the median (but is still significantly higher than the salary of conscripts).

As mentioned above, the non-pecuniary benefits relevant at the recruitment point are mainly based on the prospect of safe employment. Overseas deployments, which have been on the increase in the last years, provide another set of relevant monetary and non-monetary benefits. Junior enlisted volunteers benefit from a monthly deployment allowance of about Lit. 3.5m per month. Moreover, surveys show that overseas deployments are an important source of satisfaction and motivation for

[30] Income adjusted for nominal wage growth for comparative purposes (nominal wage growth data taken from the Economist Intelligence Unit's *Country Profile* on Italy (2000). The income distribution presented here is a sub-sample of a large household survey conducted on a yearly basis by the Bank of Italy. For more summary results and a methodological discussion that includes the limitations of this data, refer to Appendix B.

both those serving and those wishing to serve (Battistelli, 1996; Battistelli et al., 1999).[31]

The Army does not offer educational benefits—such as tuition support or an allowance for living expenses while studying—to VFAs or VFBs. Marshals instead do receive educational benefits during the first two years of service, which are spent at the NCO academy: the training and coursework leads to a "shortened" university diploma. Financial incentives for recruitment do not include signing bonuses for particular skills areas, although the compensation system differentiates somewhat between different combat specialties (more on this in Chapter 3).

To increase the human capital development prospects of its junior enlisted soldiers, the Army has organized a set of training programs for junior enlisted volunteers, called *Euroformazione*. These programs were originally instituted in 1997 with the support of the European Union to impart conscripts with foreign language (English), information technology, and other professional skills.[32] *Euroformazione* has been extended to VFBs, and in the 12-month period ranging from January 22, 2000 and January 23, 2001, more than 700 courses were offered to VFBs, with approximately 9,000 students attending (Italian Joint Staff, 2001).

Recruitment establishment

The Army has only recently begun to prepare for the task of attracting and eventually recruiting large number of volunteers on an ongoing basis. To do so, it has created an agency in charge of all advertising and promotional activities (*Agenzia Promozione Reclutamenti*, or **APR**). Some of APR's activities include advertising aimed at recasting the hitherto unfavorable image the Army has among military-age youth, as well as ads that inform the target population of upcoming contests and their terms and conditions.[33]

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[31] Overseas peacekeeping deployments have also helped improve the image of the Army among Italian youth since the mid-1990s. See Moriero, (2000).

[32] Sixteen technical professions are directly targeted, and include electrician, carpenter, and mechanic. At the end of the course, the student receives a certificate which allows him/her to apply for a license to practice the profession once he/she leaves the force.

[33] According to the 2000 Army's communication plan, Italian youth see the Army as relatively weak in terms of military capability,

This agency has organized other activities, such as itinerant Army exhibitions targeting beach communities during the summertime (according to Army recruiting planners, these have generated substantial interest among youth). There are also plans to involve a designated group of Army personnel in a series of middle/high school conferences. The latest Army communication plan also calls for the establishment of "military points" throughout Italy which will bring the service closer to prospective applicants and will help disseminate information on enlistment and careers (APR, 2000).

Currently the Army does not systematically consider personnel quality when making plans for recruitment. Army planners argue that qualitative standards are built into the examination process, but there are no recruitment goals based on a commonly used quality scale. There is also no sign that goals are specified for particular skill sets (e.g., combat arms) at the point of enlistment. Moreover, there is no dedicated military staff whose main task is recruitment at the "operational" level. Existing and planned outreach activities primarily concern the dissemination of information and promotion, rather than actual recruitment. In sum, the Italian Army seems to be taking a relatively passive stance when dealing with the supply of enlisted personnel.

2.3 RECENT RECRUITMENT PERFORMANCE, TRENDS, AND IMPLICATIONS

Partly as a result of such passivity, the performance of the military's recruiting establishment has been checkered. Recruitment problems began to arise when the services substantially expanded their yearly volunteer enlistment goals in the mid-to-late 1990s. This section provides a brief account of recruiting trends and of the structure of the recruiting process.

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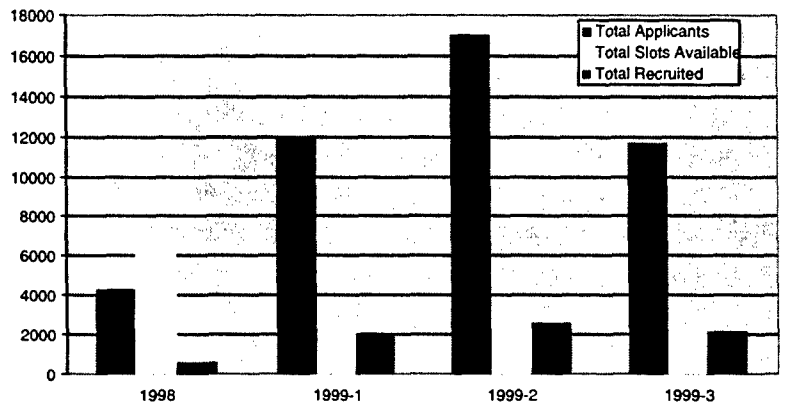
especially when compared to allied forces such as the UK, France, and Germany, and the U.S. Is it often perceived of as a badly managed, wasteful force. Youth also appear to be little informed about what an Army career can offer (APR, 2000).

VFB Recruitment

The Army has been experiencing significant problems since 1998, the first year of inter-service recruiting (see Figure 2.2). In that year the number of applications was even lower than the available slots, and only a fraction of the applicant pool was actually recruited (the rest of the intake for that year—about 6,000 soldiers—was secured through an Army-service contest, which had laxer selection standards). The situation seems to have improved in 1999, with a much higher applicant-to-slot ratio.[34]

Figure 2.2 Joint VFB recruiting contests, 1998-1999



source: based on Army General Staff data

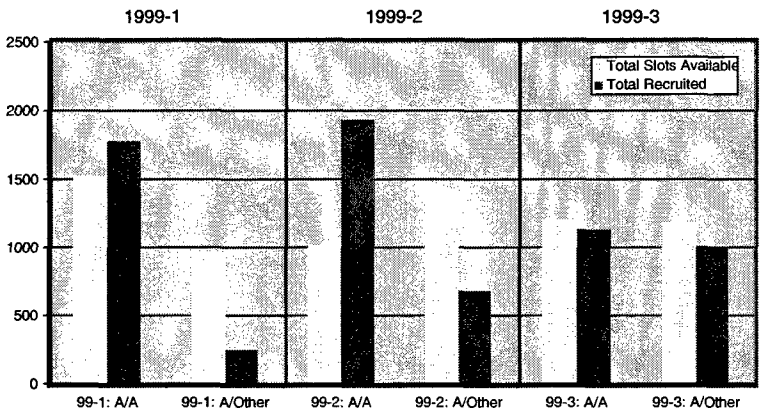
Having said that, the increase in the number of applications relative to the available slots does not automatically lead to larger numbers of high-quality recruits. As mentioned in the "recruitment process leaks" sub-section below, the number of individuals that actually undergo the selection process is a significantly smaller fraction of those who apply. Since there is no systematic screening of applications prior to their filing, there exists a possibility that the increase in applicants is driven by a greater supply of low-quality or otherwise undesirable individuals. Indeed, some Army planners have

[34] To explain the particularly dismal performance of 1998, Army planners cite the fact that many of the flaws affecting the process were due to its infancy: the military was not successful at reaching potentially interested youth prior to the contest; the selection criteria were not properly calibrated, and bureaucratic coordination within and across each service and police forces proved difficult.

expressed their concerns that selection standards are "not overly demanding" (Castelluccio, 1999).

Figure 2.3 instead indicates that generally half of the individuals enlisting opt to join other police forces once their term is over. It also highlights the fact those security forces responsible for recruiting personnel loaned to the Army have not secured as many enlistments as planned--thus forcing the Army to exceed its goals and make up for the deficit. This in large part reflects the reluctance of police forces, who dislike the fact that their own personnel selection process is being constrained in order to meet the manpower needs of the military.

Figure 2.3 Recruitment patterns by post-first-term career choice, 1999



source: based on Army General Staff data

Marshals recruitment

The recruitment experience for the Marshals category has been qualitatively different than for VFBs. Relative to the few lateral entry positions offered each year, the number of applicants is staggering: in the 2000-2001 contest, 18,400 applicants competed for a mere 210 positions (the 1999-2000 contest had a comparable ratio). This is not surprising given the considerable advantages—in terms of compensation and human capital development—of becoming a Marshal immediately after high school.

VFA Recruitment

VFA recruitment began in 2000, and monthly demand for these recruits has roughly oscillated between 1,000 and 1,500. By the end of

2000 more than 13,000 individuals enlisted as VFAs. According to the results of surveys administered to VFAs, it appears that a significant number of them has chosen this route as a preparatory step for a career in the Army (even larger numbers indicated draft-related rationales, such as better salary and choice of location).[35]

Recruitment process leaks

One of the principal recruitment problems may well have to do with the management of the process *after applications are filed.* The data presented in Figure 2.4 was obtained by following a group of applicants in the 2000 Marshals contest. It appears that more than half of those applicants deemed acceptable drop out before the first test is administered. Based on Army General Staff data, the attrition pattern for VFB applicants should be largely the same--if not worse. Another looming problem is the fact that the selection process takes a whole year from end to end because of bureaucratic and infrastructure bottlenecks.

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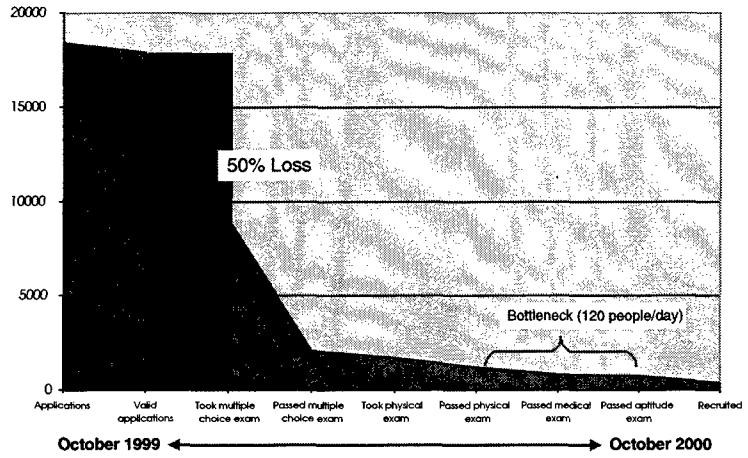
[35] The potential that VFAs have of becoming an important flow into the stock of longer-term volunteers is underscored by data available for the additional recruitment contest organized in 2000 (the only one for which it is possible to reconstruct the background of applicants). These show that applications from VFAs easily surpassed those of civilians and conscripts. See Favara and Zizzo (2000) and Sgritta (2000).

Figure 2.4 Recruitment process leaks: Marshals contest, 2000-2001



source: based on Army Schools Inspectorate data

To be sure, some attrition during the selection process is natural (and even desirable) since individuals who apply may also be pursuing other career options and may not be truly motivated to join the military. However, such a high loss rate may be in large part affected by the centralized, bureacuratic, and applicant-unfriendly format of the selection process. In fact, past contests (1995/1996) that allowed applicants to take the first exam in locations closer to their homes (there were three exam sites--in the North, Center, and South) saw pre-exam attrition rates drop to 20-25% (Colimberti and Masini, 2000).

Regional representativeness

Finally, recent recruiting data collected by the Army points to the disproportionate number of Southern applicants. In fact, while Southern youth makes up 40% of the country's military-age male cohort, it generally accounts for 70% of the applications. Equally significant is the lack of representation of Northern youth, which contributed 5% of the total number of applications submitted in 1998, despite the fact that it accounts for one-third of the eligible cohort.[36] Such regional

[36] This trend is even starker when one examines the regional background of actual VFB recruits. Army data shows how three Southern regions-- Sicily, Apulia, and Campania--contain a third of military-age youth, yet they account for two-thirds of VFBs currently in service. Relatively populous Northern regions such as Lombardy, Piedmont and

imbalances are caused by several factors, including the higher unemployment rates and lower wages in the South. They currently remain below the policy horizon, and although the debate over regional representativeness will never assume racial or ethnic overtones, the rhetoric could well escalate during a time of crisis (especially in the case of heavy losses).

Veneto jointly contribute less than 4% of total VFBs (Italian Army General Staff, 1999).

3. CAREER FORCE MANAGEMENT

The labor supply issues affecting personnel that have gone beyond the first enlistment point are particularly significant in an all-volunteer environment. The potential productivity (and costs) of professional soldiers place a premium on establishing promotion and compensation policies that avoid the premature loss of valuable personnel (or the protracted stay of less valuable individuals) and align individual goals with those of the organization.

This chapter begins to explore such policies, as well as their theoretical and empirical foundations. It is divided into four main sections: the first discusses the decision to stay or leave the military, and the impact force management policies have on such decision. The second instead explores the effects that promotion and compensation policies have on effort supply—a phenomenon that is less observable than stay/leave behavior, but which is equally important. Section three explores the Italian experience in these areas, while the concluding portion of the chapter highlights a set of key policy issues.

3.1 PROMOTION, RE-ENLISTMENT AND ATTRITION[37]

Evidence from past research: theoretical models and empirical findings

This section briefly reviews the theoretical foundations of models that have been developed to analyze retention (and therefore attrition) behavior. It then proceeds to discuss empirical estimates of such models.

Theoretical models

One of the earliest and most widely-used frameworks for understanding the stay/leave decision is the Annualized Cost of Leaving (ACOL) model (Enns, Nelson and Warner, 1984, Warner and Goldberg,

[37] A large portion of section 3.1 is based on studies first summarized by Warner and Asch (1995).

1984).[38] The ACOL model calculates a cost of leaving that is a function of:

- relative pay over a fixed time interval,
- changes in retirement benefits,
- changes in civilian opportunities due to military service,
- and the present value of the net preference for civilian life (Warner and Asch, 1995, p. 361).

The ACOL model has been employed in a wide number of studies, but it suffers from a series of theoretical limitations (Gotz and McCall, 1984, and Gotz, 1990).[39] These limitations were addressed by Gotz and McCall (1984) with an alternative model based on dynamic programming. This model calculates the *expected gain from staying* (or the expected cost of leaving) by estimating the difference between expected utility if the individual stays and the value of leaving immediately. The analytical framework allows uncertainty to be taken into account, since individuals make decisions by evaluating the returns to all possible promotion and separation sequences. These are then weighted by the chance of their occurrence, which in turn depends "on tastes, the importance of random shocks to retention decisions, and the likelihood of promotion at each rank/year-of-service (YOS) point" (Warner and Asch, 1995, p. 363).[40]

Empirical findings

Studies on personnel retention in the U.S. military have been carried out since the early 1980s; Table 3.1 summarizes the evidence from a selection of these.

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[38] Originally cited in Warner and Asch (1995), p.360.

[39] ACOL's single dominant time horizon prevents it from factoring in the uncertainties related to the occurrence of random events and future promotion opportunities (as well as the possibility of involuntary separation). For more details, see Warner and Asch (1995), pp. 362-363.

[40] This model produces equations for the probability that a given individual will remain in service from period 1 to period *t;* these are then estimated through econometric analysis.

Table 3.1 Empirical estimates of re-enlistment behavior[41]

Study	Period	Service	Skill	Term	Term Pay Elasticity	Re-enlistment Bonus effect
Warner and Goldberg[42] (1984)	1974-1978	Navy	Ship maint.	1	2.12	0.023
			Aviation maint.	1	2.46	0.032
			Administration	1	2.44	0.042
Hosek and Peterson (1985)[43]	1976-1981	Air Force	Pooled	1	3.8	0.02 (install.)
				2	1.7	0.025 (lump-sum)
						0.024 (install.)
Quester and Adedeji (1991)[44]	1980-1990	Marine Corps	Pooled	1	1.64	0.066
Smith Sylwester and Villa (1991)[45]	1974-1983 entrants	Army	Infantry	1,2	1.29, 0.86	
			Maintenance	1,2	1.76, 1.12	
			Administration	1,2	1.90, 1.76	
Buddin et al. (1992)[46]	1983-1989	Army	Pooled	1	1.05	
			Infantry	1	1.40	
			Comm. & Intell.	1	1.34	
			El. & mech. maint	1	0.87	
Daula and Moffitt (1991,1992)[47]	1974-1983 entrants	Army	Infantry	1,2	Large	

[41] Based on Warner and Asch (1995), pp. 364-365.

[42] Microdata, probit model of reenlistment vs. separation, pay variable is ACOL.

[43] Grouped data, trivariate logit model of reenlistment, extension, and separation, pay variables are military to civilian (M/C) wage ratio and SRBM.

[44] Microdata, logit model of reenlistment vs. separation, pay variables are M/C ratio and SRBM.

[45] Microdata, bivariate probit model of first- and second-term reenlistment vs. separation, pay variable is ACOL.

[46] Microdata, two-equation model of months to E-5 and reenlistment vs. separation, pay variables is the M/C ratio adjusted for promotion timing and SRBM.

[47] Microdata, panel probit of first- and second-term reenlistment decisions; pay variables is the stochastic cost of leaving.

Table 3.1 summarizes the effects of two policy levers: pay and re-enlistment bonuses offered to U.S. military enlisted personnel.[48] Various studies show that both levers are effective at increasing retention, although their effectiveness decreases for hard-to-fill occupations such as infantry (Warner and Asch, 1995, p.366). Newer studies explicitly controlling for promotion tempo also show reduced pay elasticities across the board (Buddin et al., 1992).

Warner and Asch (1995, p.366) note that a number of research studies also share the following conclusions:

- Re-enlistment probability is greater for those who originally enlisted for longer terms;
- Holding retention standards constant, a higher unemployment rate increases retention;
- Propensity to enlist is lower for those with higher education levels and test scores, but the difference decreases with YOS;
- The greater the value of educational benefits, the lower the probability of re-enlistment.

3.2 PROMOTION AND COMPENSATION

The impact of compensation and promotion policies on individual decision-making and effort supply is examined by Asch and Warner (1994) with a generalized version of the Gotz-McCall dynamic programming model mentioned above. The Asch and Warner model is used to explore how effort supply depends on the structure of pay. It assumes that an individual has a specific ability parameter which he/she knows about but which the military is unable to know a priori. It also assumes that an individual can produce a variable amount of effort depending on (1) the structure of pay, (2) outside opportunities, and (3) taste for military life. At each point in a soldier's career both he/she and the organization decide whether to continue the employment relationship. The military assesses individual performance using a periodic evaluation, which is used both for promotion and separation. Promotion probabilities depend on

[48] The size of such bonus depends on a multiplier called SRBM (Selective Re-enlistment Bonus Multiplier) which takes into account occupation and years of re-enlistment.

individual effort, as well as on the effort of others (Warner and Asch, 1995, p. 382)

The *net expected gain to staying* is the expected return to staying minus the return from leaving. These returns are weighted by the probabilities that both the individual wants to stay and the military wants to retain him/her. Individuals desire to stay only if the net expected gain is greater than zero (plus a random element to the retention decision). Based on the marginal utility of effort function derived from the model, Asch and Warner highlight a series of implications for how this expression varies according to different compensation and promotion policies. These are summarized below.

Active pay considerations

The model has direct implications for how to structure active-duty pay—both between and within grades.

Intergrade pay spreads and promotion probability

Intergrade pay spreads need to be skewed whenever the marginal productivity of individuals is expected to rise with grade. In order to keep the effort supply of workers constant, pay differentials between grades need to offset the decrease in promotion rates as one moves up a hierarchy (Asch and Warner, 1994, p. 92).[49] Equally important is the insight that a skewed pay profile will be most effective when promotion chances depend primarily on effort. All other things being equal, individuals will exert less effort if promotion probability is either very high or very low. *Promotion probability can be very high when it is based on simple time-in-grade requirements. It can be correspondingly low when individuals reach terminal grades, or when the promotion system is "clogged" by the absence of regular turnover in the higher grades.*

Intragrade pay

The model also indicates that effort supply could be stimulated by introducing intragrade pay spreads, as in the case of performance-based

[49] This result is consistent with Lazear and Rosen (1981), Nalebuff and Stiglitz (1983), and O'Keefe, Viscusi, and Zeckhauser (1984). These studies are originally cited in Asch and Warner (1994).

pay. Such measure could help offset the reduced importance of intragrade pay spreads when promotion opportunities are small, the pay profile is flat, or when or when individuals have reached their terminal grade and cannot be easily removed (Asch and Warner, 1994, p.97).[50]

Retired pay considerations

An individual's decision to stay or leave the force is also influenced by retired or separation pay. In fact, Asch and Warner argue that the military should consider retired pay not as a means to transfer consumption from the present to the future, but rather as an policy lever used to actively manage the experience and grade profile of the force. Retirement benefits could play a role in separating older personnel; separation is often beneficial from the organization's standpoint because it increases the promotion opportunities for younger and able personnel, which in turn are necessary to motivate effort supply in the lower ranks. (Asch and Warner, 1994, pp.101-102)

Up-or-out rules

The Asch and Warner model also considers involuntary separation as a policy lever. Involuntary separation would occur when individuals fail to meet minimum performance standards. For the vast majority of individuals, up-or-out rules boost effort supply, since additional work lessens the prospect of early career termination (Warner and Asch, 1995, p. 384). Performance-based promotion policies can also help in retaining personnel that could contribute the most to the organization, since more talented individuals would face better promotion probabilities and therefore higher expected gains to staying (Asch and Warner, 1994, p.73).

3.3 FORCE MANAGEMENT: THE ITALIAN EXPERIENCE

This section provides an overview of the Italian Army's personnel system by describing current promotion policies and the retention

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[50] The pay differentials between grades need to be greater than those within a grade in order not to blunt promotion incentives for those who could make a greater contribution at higher ranks (Asch, 1993, p. x).

behavior based on data from recent years. It then outlines the major features of the compensation system—both from the standpoint of active and retired pay.

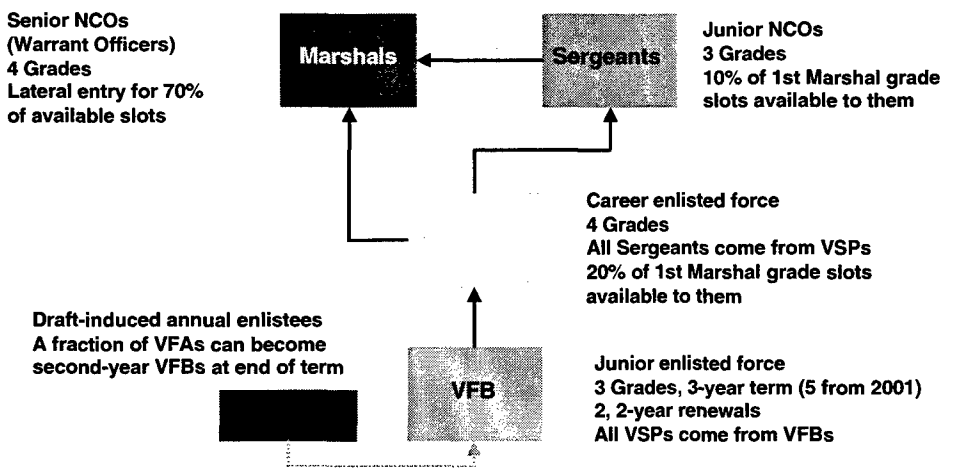
A brief introduction to basic personnel categories and flows

The career management system in the Italian military is based on a number of personnel categories that comprise several grades. Personnel flows occur between categories, as well as within each.

The VFB enlisted soldiers described in Chapter 2 make up the most junior category.[51] At the end of their term, those in the terminal VFB grade and with the requisite years of service are eligible to become part of the career enlisted force (*Volontari in Servizio Permanente*, or **VSP**). VSPs are major corporals--essentially blue-collar military workers--to be employed in combat roles for the first half of their career, and then reassigned to support and administrative tasks for their remainder of their military life.

There are four grades in the VSP category. While some individuals will reach the terminal grade as VSPs, others will instead be promoted into the NCO ranks either as a **Sergeant** or **Marshal** (see Figure 3.1).

Figure 3.1 Career progression between different personnel categories



Sergeants include 3 separate grades, and are drawn from the VSP stock. These are junior NCO personnel, and their responsibilities

[51] Since VFAs are not career-track soldiers, they are not included in this discussion.

include training and command of small teams—such as a tank crew. Marshals are instead more akin to warrant officers and those who reach the highest of the four Marshals grades can actually substitute for an officer in his/her duties should the latter become incapacitated. Marshals also have specialist and technical roles, and those deployed in operational units command platoons (Sampaolo, 1995). As mentioned in Chapter 2, Marshals are in large part recruited laterally (70% come from the civilian world, while 30% are promoted vertically). Both VSPs and Sergeants can become Marshals: 20% of the year's available slots are assigned to the former, with the remaining 10% is reserved for the latter.[52]

All of those who move beyond the VFB stage are essentially employed for life, since retirement comes after approximately 37 years of service, and given that there are no up-or-out rules. While some soldiers will move from the VSP category to become a Sergeant or Marshal, others will instead reach the terminal VSP grade and eventually retire. The actual number of individuals transitioning from one category to another is a variable in the hands of Italian policy makers, and will be thoroughly explored in the modeling chapters. The next section instead sketches the flow of personnel through the ranks more precisely (these flows are summarized graphically in Appendix C).

Promotion policies

VFBs

For VFBs, the first promotion to VFB2 (from private to corporal) comes automatically after 3 months of service, while the second promotion to VFB3 (major corporal) is automatically awarded to all who complete the 12th month of service.[53]. At the end of the term (3 years for those recruited through 2000, five years for those who enlisted in 2001 and beyond), the top personnel is chosen for the career force, based on a ranking system that takes into account past performance on a

[52] However, these proportions could change as the Army reaches a steady-state, with more Marshals being promoted from the lower ranks.

[53] The timing of VFB promotions once the enlistment term is lengthened to 5 years will be slowed accordingly, although details remain undefined.

number of measures. Some of the VFBs instead join other police forces or return to civilian life. Others still may want to renew their term for a maximum of 2, 2-year periods. VFBs who renew earn additional "points" which may increase their chances of being selected into the career force.[54]

VSPs

As VSPs, personnel progress automatically from each of the four grades (VSP1, VSP2, VSP3, VSP4) to the next with 5 years in grade (with the exception of the promotion from VSP1 to VSP2, which requires 1 year in grade).[55] VSP4 is the terminal grade for this category, but as mentioned above VSPs can seek promotion into the NCO ranks. Sergeants are fully composed of former VSPs, and each entry-level Sergeant cohort is selected annually through a competitive process. Seventy percent of the slots available each year are dedicated to VSP4 personnel, while the remaining 30% of the positions are dedicated to VSP2s and VSP3s. VSPs can also compete for promotion into the Marshal grade; eligible candidates must be high school graduates with at least 7 YOS and under 40 years of age. In each year, 20% of the slots are dedicated to VSP personnel who have the requisite skill set.

Sergeants

There are three grades in the Sergeants category (S1, S2, and S3): eligibility for promotion from S1 to S2 and S2 to S3 comes into effect after seven years in each grade, but promotion is not triggered by simple time-in-grade thresholds.[56] It instead takes place through an intricate selection process—termed the *"by choice"* system—as follows: after seven YOS in the grade, the top one-third of the eligible cohort (c_o) is promoted. The remaining soldiers are evaluated for a second

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[54] Some former VFBs also attempt to become Marshals by entering laterally to the senior NCO category as civilians. Former VFBs benefit from some preferential treatment in the Marshals contest (they are awarded extra points to account for their prior military experience), but they are not entitled to a yearly quota of Marshals slots.

[55] VSP1 stands for the rank of 1st Major Corporal; VSP2 for "Chosen" Major Corporal; VSP3 for Chief Major Corporal; VSP4 for "Chosen" Chief Major Corporal.

[56] S1 stands for the rank of Sergeant; S2 for Major Sergeant; S3 for Chief Major Sergeant.

time in t+1. The upper half of these is promoted in t+1, with a class rank below those from the next cohort (c_1) who are promoted in their first year of eligibility. The lower half is instead promoted in t+2, with a class rank that is below those from the cohort c_1 who are promoted after the second review.[57] All Sergeants are eligible for promotion to the Marshal grades, but in order to compete in the promotion contests they have to possess a "above average" rating and no more than 40 years of age (approximately 20 YOS).

Marshals

Promotion to the Marshal category takes place through competitive examinations. As mentioned before, 70% of the available slots for the entry-level Marshal grade (M1) are currently dedicated to applicants joining the force laterally. Lateral entrants spend the first two years of service at a NCO academy for training before being assigned to operational tasks. The progression of Marshals through the four grades is triggered by time in grade rules (as in the move from M1 to M2 after 2 years in grade), as well as by a selection process similar to the one outlined for Sergeants (for the promotion from M2 to M3). The promotion to the terminal M4 grade is instead a hybrid of the two: 70% of the slots follow the "by choice" system after 8 years in the M3 grade, while the remaining 30% are allocated through a competitive process.[58]

System behavior: promotion and retention

The system described above was first implemented in 1996, and therefore indications on the behavior of individuals moving through it are limited. Individual choices in such a system are also highly contingent on the peculiar properties of a transition: some of the stocks were created with little to no personnel, and Army planners were prompted to exceed steady-state accession requirements in order to meet the short-term manpower goals set by the Parliament (VSPs and Sergeants in particular--more on this in Chapter 4). This means that a very large

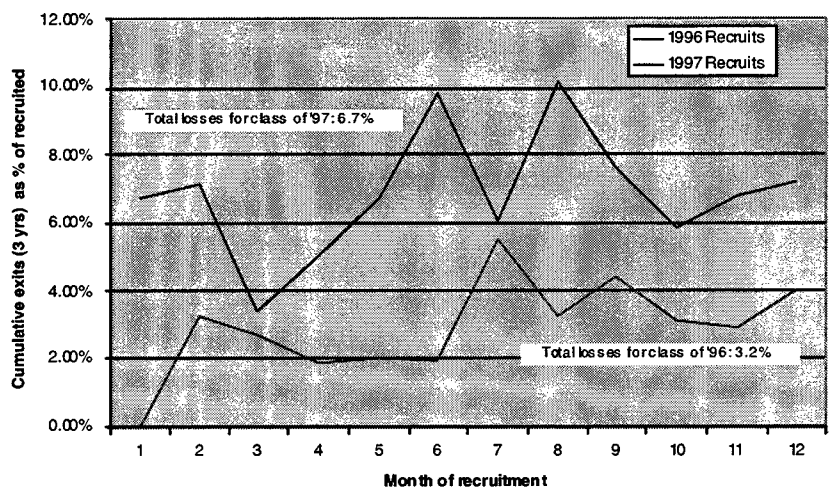
[57] Class ranks has an impact when the number of individuals to be promoted is lower than that of those elegible for promotion. In such a circumstance, the order of promotion would reflect class rank.

[58] M1 stands for the rank of Marshal; M2 for "Ordinary" Marshal; M3 for Chief Marshal; M4 for "Aide."

portion of soldiers wishing to transition from VFB to VSP, and from VSP to Sergeant, *have been able to do so*.[59] The fact that some personnel stocks such as VSP and Sergeants were established in 1996 as virtually empty reservoirs also means that the behavior of personnel who have spent a considerable number of years in these categories cannot be ascertained. The promotion patterns for Marshals (and into the Marshals category) are rather different since this stock is instead well over the steady-state amount and will therefore have to diminish over time.

High promotion rates have been coupled by low retention rates across the board. Out of all the VFB who entered in 1996, only 3.2% dropped out by the end of the term; for the class of 1997, the attrition rate is of 6.7% from beginning to end (see Figure 3.2).

Figure 3.2 Retention for VFBs



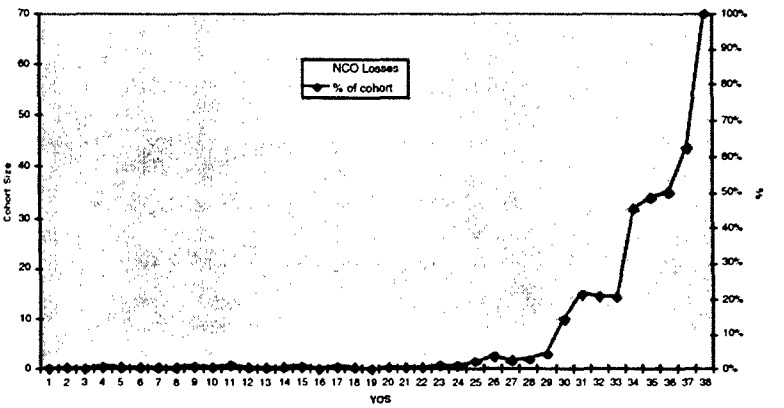
source: based on Army General Staff data

While no data is currently available to quantify attrition in the VSP ranks, Italian officials have claimed that it has been equally small (their planning factor is 1% per year). NCO data (mainly of Marshals since the Sergeant stock only recently began to take personnel) is also consistent with this trend. Army General Staff data typically show minimal attrition rates for those with less than 30 YOS; attrition

[59] For instance, many VFB who were not promoted as VSPs immediately at the end of their term have been able to join the career force during or after the two 2-year renewals.

gradually increases, and most individuals retire by the time they reach the 37th year of service (see Figure 3.3 for a representative sample of NCO loss rates by YOS). It is important to realize that this 37-year limit applies the administrative YOS count, which in effect implies that the *actual* retirement age is three years lower (at around the 34th YOS).[60]

Figure 3.3 NCO Losses by YOS cohort, January-October 2000



source: based on Army General Staff data

Active-duty pay[61]

The major compensation elements include active-duty pay (both- its structure and its level relative to civilian pay), retired pay, and non-monetary benefits. Each is briefly discussed below.

Components and structure of active-duty pay

Active-duty pay is primarily determined by grade, although adjustments for YOS and type of employment are factored in. Leaving aside YOS-dependent compensation, the major elements of pay include: (1) a basic salary, (2) a cost of living adjustment (*indennita' integrativa*

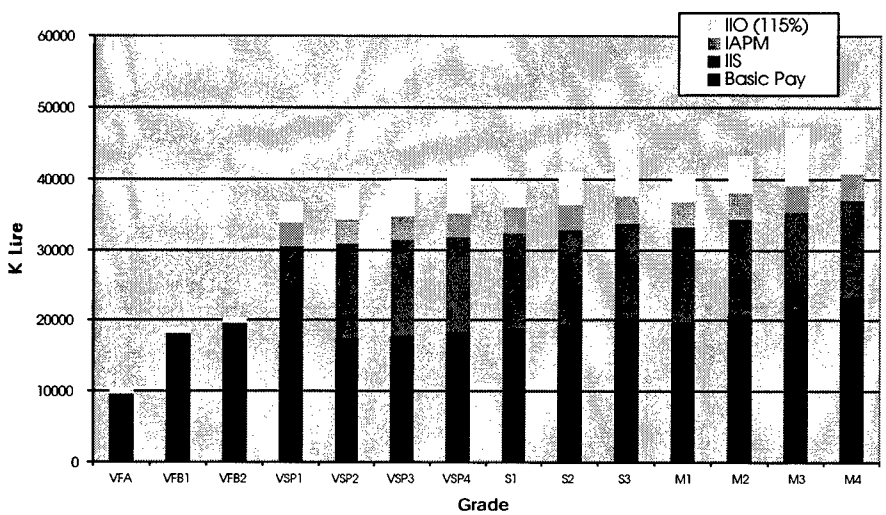
[60] As first mentioned in Chapter 1, individuals accumulate years of service for administrative purposes that exceed their actual years of service when they are deployed in operational units. Typically, soldiers can expect to accrue three extra years of service at career end. Army planners have recommended modeling the current actual career length as having a limit of 34 YOS, and progressively increasing it to 37 by 2008 (see Chapter 7).

[61] The results are based on several discussions with Army planners and on compensation policy papers, the most important of which is Italian Army General Staff (2000a).

speciale, or **IIS**), (3) an additional pension contribution (*importo aggiuntivo pensionabile mensile*, or **IAPM**), and an operational allowance (*indennita' impiego operativo*, or **IIO**).[62]

Basic pay and IIS are solely functions of grade. In turn, the amount for each grade is determined by a pay tier system that regulates the salary of all public sector employees, with a minimal percentage increase for those grades that share the same pay tier. The IAPM is a small part of total salary, and instead varies by groups of grades (e.g., all four VSP grades receive the same amount). As shown in Figure 3.4, the differences in basic salary, IIS, and IAPM are minimal across grades. The only exception to this pattern is the large difference that exists between VFBs and career personnel.[63]

Figure 3.4 Active-duty before-tax pay (basic, IIS, IAPM, IIO)



source: based on Army General Staff data

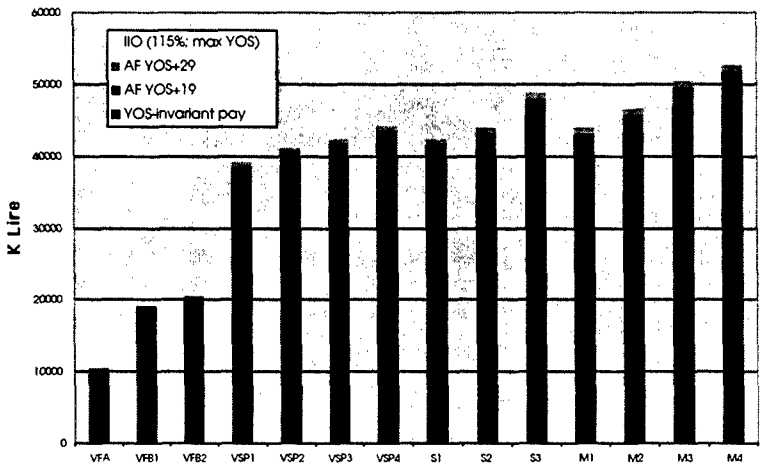
The IIO adds some skeweness to the intergrade pay profile. The actual IIO amount each person receives varies by grade—and as Figure 3.4 shows, the terminal grade for each category has a higher amount of IIO than the starting grade of the next. IIO also varies by the type of

[62] Another important element of compensation is the daily deployment allowance (*Alta Valenza Operativa*, or **AVO**). It is not considered here because of its contingent nature.

[63] The pay for M1s unadjusted for YOS is lower than that of S3s to reflect the fact that junior M1s are lateral entrants and have less experience than many Sergeants and VSPs.

work an individual soldier is assigned to: those belonging to deployable units can earn up to 35% more than their colleagues assigned to more administrative tasks, while those employed in elite units such as the amphibious battalion earn as much as 80% more. Army planners estimate that a typical soldier earns on average 15% more than the basic IIO amount set in the pay tables, and this additional amount is used as the IIO per-soldier estimate in Figure 3.4 and in future chapters. Army pay tables also show that there are IIO increases at certain years of service thresholds—but only for certain grades.[64] Figure 3.5 indicates that most of the YOS-contingent increases in IIO are concentrated in the middle grade of the Sergeants category (S2) and the middle grade of the Marshals category (M2). This figure also shows that the Army compensation system takes YOS into account with a seniority allowance for those with more than 19 and 29 years of service (*assegno funzionale*, or AF). The actual amount of AF varies from one category to another (e.g., VSPs vs. Sergeants).

Figure 3.5 Elements of pay contingent on YOS[65]



source: based on Army General Staff data

It is important to note that the current compensation system differentiates pay by different levels of operational intensity, *but not*

[64] YOS-related increases in IIO are limited to S2s with 15 or more YOS; M1s with 5 or more YOS; M2s with 10 and 20 or more YOS; M3 with 25 or more YOS; M4 with 25 and 29 or more YOS.

[65] For IIO the actual amount represents the maximum variation of pay by YOS for each grade.

by occupational category. Moreover, it does not include elements of performance-based pay.

How skewed is the intergrade distribution? The result is not at all obvious, since individuals do not necessarily follow a linear, hierarchical progression through the grades. In fact, one can think of the four categories not as pyramids, but rather rectangles: promotion within them is automatic (although sometimes subject to delays), and virtually everyone is assured the possibility of reaching the stock's terminal grade. The hierarchical aspect of promotion sets in when individuals seek to be promoted from one stock to another: from VFB to VSP, from VSP to Sergeant, and from Sergeant to Marshal. Therefore, the critical question to ask is whether the differences in pay between *stocks*, and not necessarily adjacent grades, provide a sufficient incentive for those who could make a significant contribution in the higher stocks to seek such a progression.

Table 3.2 Inter-category and Intra-category pay spreads (% increase)

Inter-category (average)			
	To:		
From:	VSP	Sergeant	Marshal
VFB	98.5%	-	-
VSP	-	6.5%	15%
Sergeant	-	-	7.9%
Intra-category			
	To:		
From:	VSP4	S3	M4
VSP1	13.5%	-	-
S1	-	16.4%	-
M1	-	-	21.5%

The first half of Table 3.2 provides a rough estimate of inter-category differences—using a simple average of pay for each category (based on pay for each grade in the category), this table shows that the pay spread is extremely high in the first category transition from VFB to VSP (98.5%). The spreads then diminish to less 6.5% and 8% for the transition between VSP and Sergeant and between Sergeant and Marshal, respectively. For those who transition from the VSP stock directly to the Marshals category, the average percentage change in pay increases to

15%. Some of the flatness of the post-VFB pay profile is related to the fact that the first two grades in the Sergeant and Marshal stocks are assigned a lower salary base than the terminal grades of the preceding stock (see Figure 3.4).[66]

Table 3.2 also provides the intragrade pay spreads, unadjusted for (fairly small) YOS differences. These show that the the variance between the entry and terminal grade for each category is significant, and in most cases greater in percentage terms than the differences between categories.

Estimating earnings profiles

The foregoing discussion provides a framework for how pay changes across grades and categories. But career trajectories can vary significantly among personnel—for instance, some can seek promotion to S1 as VSP2s, without having to reach the terminal grade of VSP4 in order to make the transition. Therefore a soldier's actual pay profile depends on his/her path across grades and categories.

Pay profiles are estimated for three different VSP career trajectories in Figure 3.6. The first trajectory, called "S1 @ 8 YOS," includes fast trackers who are able to earn a promotion to S1 quickly (with 8 YOS), and then swiftly progress to the terminal S3 grade with 22 YOS. The second trajectory of "S1 @ 15 YOS" includes those who become S1s at the 15 YOS mark, reaching the terminal grade of S3 by 31 YOS. Those in the VSP4 @ 16 YOS trajectory instead never become Sergeants, and reach the terminal VSP4 grade with 16 YOS.[67] For all, the career is assumed to end at 37 YOS.

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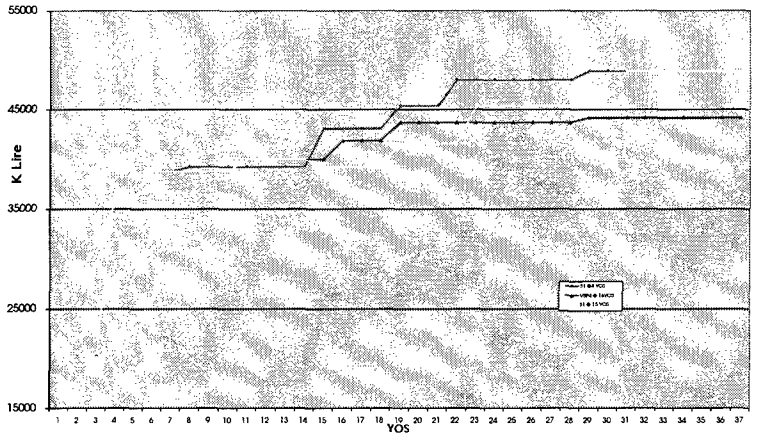
[66] This in turn is due to the fact that in the short run no personnel from the senior VSP and Sergeant ranks will be promoted to a higher category (these grades are empty). Army planners reckon that, once inter-category promotions will include senior personnel, an allowance will be created in order to prevent a pay cut.

[67] This analysis assumes a three-year VFB term. The results are generally applicable to a 5-year term, however.

Figure 3.6 Earnings profile for different VSP/S career tracks

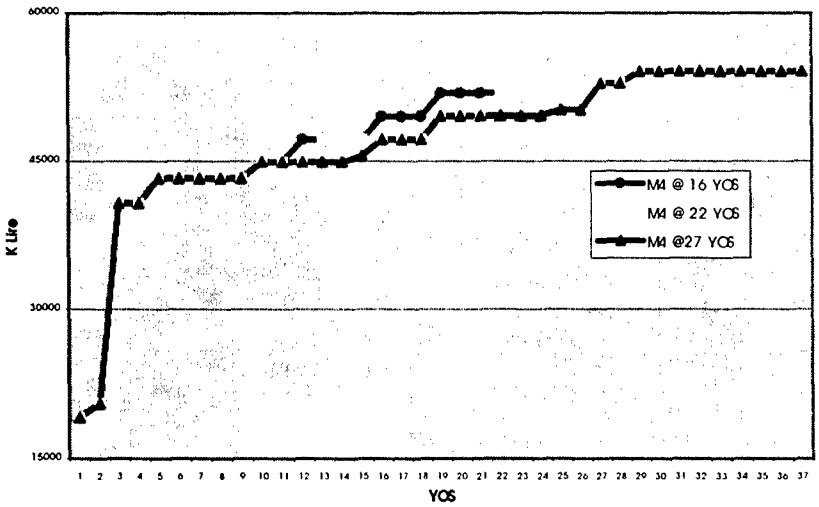


The chart shows that pay does increase more quickly for fast trackers than for those in the middle or slow track. The pay level is also higher: at around 30 YOS, individuals in a S1 @8 YOS trajectory can earn an additional Lit. 4m more per year compared to slow trackers (a 10% difference). Those in the S1 @ 15 YOS trajectory experience lower pay during the mid-career phase than personnel who is never promoted to the Sergeants stock, but as they progress through the Sergeant ranks, they quickly manage to overtake individuals in a VSP4 @ 16 YOS trajectory.

Figure 3.6 also indicates that salaries are almost identical among the different tracks until the 15th YOS. Moreover, and especially for slow and fast trackers, salary ceases to increase significantly at approximately the 20 YOS mark (for middle trackers, there is a steady increase until the 30 YOS mark).

Performing this analysis for those who enter laterally as Marshals also yields some interesting results. In this case some individuals reach the terminal M4 grade after 16 YOS, others at 22 YOS, while others still at 27 YOS.

Figure 3.7 Earnings profile for different Marshal career tracks



The differences in salary among the different career paths are greatest during the mid-career phase, but are never as great as in the case of VSPs/Sergeants. Indeed, salary is identical for all paths during the early and latter stages of one's career. Figure 3.7 also highlights how the pay profile reaches plateaus that extend across a number of years. For those who become M4 after 16 YOS, the prospect of significant increases in pay diminishes drastically after 19 years of service.

Retired compensation

An individual is eligible for an Army pension after either reaching a specified age or YOS limit. For enlisted and NCO personnel, the age limit is 60, while the YOS threshold is being gradually increased in conjunction with the reform of the whole public sector retirement system: currently individuals can retire with 37 years of service, but by 2007 full retirement will occur at 40 YOS (see Table 3.3).[68]

[68] Individuals who retire can join an auxiliary force for 5 years; auxiliary duty pays approximately 80% of a soldier's active duty salary. Auxiliaries may be staffed in the military or in other public-sector institutions, and are required to serve on a full-time basis.

Table 3.3 Pension YOS thresholds[69]

Year	YOS
2000	*37*
2001	*37*
2002	*37*
2003	*37*
2004	*38*
2005	*38*
2006	*39*
2007	*39*
2008 and beyond	*40*

source: Army General Staff

Army personnel can leave the service without meeting either the age limit or the statutory early retirement criteria laid out in Table 3.3. Individuals who do so are no longer eligible for an Army pension, but their retirement contributions while in service are credited toward a pension account at the Italian Social Security Administration (INPS). In this case, retirement benefits depend on the number of additional years worked in the civilian sector.

Career force non-pecuniary benefits

Information on non-pecuniary benefits is scant, aside from the obvious benefit of job stability associated with a career in the Italian Army. During recent interviews Army officials have expressed concern at the lack of the infrastructure to improve the quality of life for personnel and their family members. For instance, Army support for housing is a pressing issue. The service controls about 11,000 housing units, but according to Army estimates only 6,600 are truly available since the remaining is (1) uninhabitable, (2) located in areas where there is no longer the need for a military presence (as in the Northeast of Italy), or (3) occupied by personnel no longer eligible. Up until recently the Army limited access to its housing infrastructure to officers and NCOs. But with the creation of the VSP category—and their entitlement to Army-provided housing—comes the added pressure of what will be a rapidly increasing number of individuals expecting benefits on this front (Italian Army General Staff, 2000b). Measures to facilitate personnel mobility such as coverage of relocation expenses, among

[69] Table 3.3 represents the YOS count that is considered for administrative purposes. As mentioned earlier, the actual years of service are generally three years lower at the end of one's career.

others—are also believed to be poor. In fact, they may blunt individual incentives to seek promotion into a higher category because such advancement often involves relocation.

3.4 POTENTIAL LONG-TERM DEVELOPMENTS

Currently the high rate of retention is in line with the theory and prior findings outlined in section 3.1. The pay differential between VFBs and VSPs is so great that it, along with the promise of job security, provides an unambiguous promotion incentive. Retention in the first term has also been boosted by the fact that promotion opportunities for those seeking to become VSPs and Sergeants have been significant—virtually everyone seeking advancement into the VSP stock is managing to do so.[70] However, as specified in Asch and Warner's model, near-automatic promotions can also have a deleterious impact on effort supply; they could also adversely affect the quality of personnel that will eventually remain in the force for an additional three decades.

More broadly, the long-term viability of the current promotion and compensation systems outlined above is open to question. While these systems have not been placed under great stress--in large part because of the peculiar patterns of the transition--such stresses and pitfalls could emerge in the future. Two "warning signs" appear to be particularly relevant:

- Under current policies, it is likely that a large fraction of soldiers will reach the terminal grade or pay ceiling by mid-career: this, along with relatively low inter-category compensation spreads and automatic intra-category promotion, may blunt effort incentives;
- The current retirement system is designed to discourage early separation; therefore, it will likely hinder personnel management as the force becomes more senior.

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[70] The end-of-term bonus given to all VFBs also serves as a significant incentive.

Long permanence in terminal grade may blunt effort incentives

As shown in Figures 3.6 and 3.7, it is very likely that individuals admitted to the career force will reach the terminal grade for a particular category and stay in that grade for several years. This could become a pressing issue for VSPs, since most will reach the terminal VSP4 grade with 20 years of service before retirement.

Given that promotion within the VSP ranks is based on automatic years-in-grade requirements, and since the system does not have strict up or out rules, some VSPs could be induced to exert less effort than they would otherwise. To be sure, the potential magnitude of the problem is largely dependent on the size of personnel flows into the terminal VSP grade and promotion opportunities out of the terminal grade (to be explored in later chapters). But were retention to stay high despite possible career and wage stagnation,[71] and if individuals were able to remain in the force without facing a credible risk of separation for lack of effort, then the Army may want to consider performance-related rewards (and/or punishments) to stimulate individual productivity. Such a policy could only be implemented after improving the Army's evaluation system, which is said to be suffering from bureaucratization, lack of standardized evaluation instruments, lack of differentiation, and grade (score) inflation (Malfe', 1998).[72] More generally, the Army should take a fresh look at the adequacy of its career personnel management processes and their long-term effects, and tailor its frameworks to suit the varying needs and requirements of individuals with different skill sets and preferences (see Chapter 9).

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[71] The possibility that attrition in the future could increase as promotion tempo between categories decreases, and as the gains is salaries associated with such promotions consequently become rarer, remains very distant in the minds of virtually all the Army planners interviewed during the course of this research. Most instead reckon that the more likely outcome resulting from stagnation in promotions would involve the creation of new grades and higher pay levels for those affected.

[72] Malfe's comments were made in reference to the officer evaluation system, but appear to be relevant for the entire force.

The retirement system discourages early retirement and could well complicate force management

The structure of the military retirement system is heavily influenced by the policies that regulate pensions for most public employees. Most notably, it has been affected by the wider move to raise minimum ages for retirement. While such changes may conform to the Treasury's wishes, they are likely to complicate force management, especially given Army plans for a relatively senior force. In general, the Army may want to start thinking about retired pay differently, and consider more actively the possibility of separation pay. The extent to which separations will be desirable, and their impact on the force profile, will be explored in later chapters. Although clearly expensive, a system that provides voluntary-separation incentives may actually be cheaper because the adverse productivity effects of a much older force could be substantial (Asch and Warner, 1994, p.103).

4. THE DEMAND FOR MILITARY MANPOWER: FORCE MIX ISSUES

An analysis of the most critical military manpower dilemmas that lie ahead for the Italian military could not be complete without considering the demand side. In addition to stimulating enlistment and effort supply, the Army needs to focus on factors affecting its own manpower requirements. In particular, the Army should explore in more detail the impact that soldier experience—and the overall experience mix—has on force management, effectiveness, and cost.

The chapter is divided into four parts. In order to provide some context for the analysis of experience mixes, the first section discusses some of the most important factors shaping manpower requirements. The second instead discusses previous studies on the impact different experience mixes can have on the military's productivity and readiness. Section 3 briefly looks at the relationship between quality, military personnel productivity and costs. The fourth section provides current data on the current and planned experience mix for the Italian Army.[73] Since experience and quality mix considerations can vary by different skill requirements and occupation, some limited data on functional/occupational personnel breakdown is also presented. The chapter then concludes with a series of policy issues that are considered further in the modeling effort.

4.1 INTRODUCTION: FACTORS SHAPING MILITARY MANPOWER REQUIREMENTS

Before delving into experience mix issues, it would be helpful to place these tradeoffs into the broader background of manpower demand and requirements. In fact, soldiers' levels of responsibility, experience, and skill—as well as their total numbers—are a function of several determinants. Among the most obvious influences is the national military strategy (such as Italy's 1995 New Defense Model). From the objectives and capabilities outlined in these strategies come a series of *direct*

[73] Quality mix considerations for the Italian Army are not explicitly covered, since data on this has so far been impossible to unearth (indeed, it may not exist in proper format).

demands for combat forces, usually measured in terms of units (divisions or brigades for the Army), and a number of *derived* demands, including specifications on the size of supporting forces and infrastructure. In turn, these demands shape the kinds of skill and experience mixes necessary to meet the strategic objectives (NDRI, 1994, p.13). Having said that, the service's needs for military manpower are not automatically determined by a specified force structure. As Kirby and Thie (1996) argue, a number of policy levers can be manipulated to alter demand--including changes in productivity, organization, technology, and substitution of one type of manpower for another or of capital for labor.[74]

These manpower requirement tradeoffs and choices are particularly evident in the Italian context. Indeed, the future requirements of Italian Army will be radically different from the ones that have hitherto been relevant. Not surprisingly, the basic impetus for this change has been the strategic decision to create a smaller but more deployable and able force. As mentioned in Chapter 1, the Army is downsizing, from roughly 175,000 soldiers in 2000 to a planned 112,000 by 2020. Moreover, since the downsizing is taking place alongside a shift from a mixed to an all-volunteer force, it also carries a host of structural and organizational considerations (e.g., who will take over those activities and tasks currently performed by conscripts?). Related to the previous point, the smaller and professional force could become more highly skilled: per soldier spending is expected to increase in order to better compensate, equip and train professional soldiers.

Such changes are likely to lead to substantially different manpower requirements. These in turn will bring to the fore a set of key resource allocation choices. For instance, active-duty force size can

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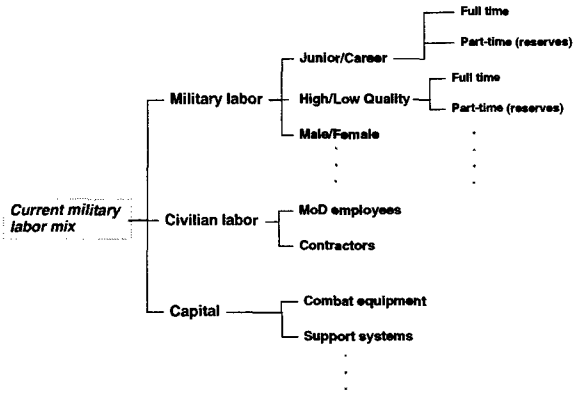
[74] Kirby and Thie go on to argue that "[f]or instance, manpower requirements can be affected by changing workload (e.g., more or fewer aircraft sorties per squadron), changing the equipment in units (technological substitution), changing the organization (reducing overhead), changing the mix of active and reserve personnel, or changing assignment and utilization policies that affect the size of the pipeline (e.g., longer tours, fewer unproductive tours, and more efficient training programs lead to smaller personnel requirements)" (Kirby and Thie, 1996, p.27).

shrink in a variety of ways while keeping a certain level of readiness, including: reductions of junior or career enlisted accessions, exits by senior NCO personnel, increased used of reserves and civilians, or introductions of labor-saving technologies.

Figure 4.1 below illustrates this point by indicating that the Italian Army has a series of options for changing the current military labor mix (in terms of experience level, skills, and so on). The first set of options concerns the substitution of one type of military labor for another. Indeed, the current mix can be altered by varying the degree to which the Army relies on junior versus senior personnel, between high and low quality individuals, and/or between men and women. In conjunction with these choices, policy makers must decide to what extent they need military labor on a full-time versus a part-time basis (i.e., through the reserves).

Figure 4.1 Input substitution options[75]



Military labor can also be substituted with civilian labor—here the most salient breakdown is between civilians employed by the Ministry of Defense and contractors, usually working through an outsourcing agreement. The Army has begun experimenting with outsourcing those support functions that have traditionally been carried with conscripts,

[75] To be sure, these are not the only options available to the military (hence the dotted marks in Figure 4.1). But they provide a starting point for thinking about what types of resource allocation choices the Army will have to be making in the transition to an AVF.

and has managed to reap significant personnel savings.[76] Finally, capital can be substituted for military labor.[77]

Scope of the chapter's discussion

Conducting an in-depth analysis of manpower requirements and resource allocation is beyond the scope of this dissertation. However, having recognized that manpower requirement decisions are affected by a series of factors, the remainder of the chapter focuses on the substitution possibilities between different types of full-time military labor. In particular, the focus is on those tradeoffs that have an impact on the experience mix, with some attention being paid to quality.

4.2 CHOOSING EXPERIENCE MIXES

The labor economics literature has underscored that worker experience, and different experience mixes within an organization, can have a profound impact on performance. Indeed, the productivity of workers depends not only on intrinsic traits such as dexterity and intelligence or on physical capital. It is also a function of their human capital--that is, the "knowledge and acquired skills a person has that increase his or her ability to conduct activities with economic value" (Milgrom and Roberts, 1990, p. 328). This section focuses on the impact that experience has on productivity and costs in the military context, drawing primarily from the literature developed in the United States.[78] Studies on the relationship between enlisted work force capabilities and characteristics have been conducted since the late 1960s. Experience has been shown to affect productivity both at the individual and unit levels. In addition, experience could have an impact

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[76] In fact, the expected savings from better resource management on the part of the Army could reach 20% of the yearly budget, according to a 1995 report by Italy's General Accounting Office (Corte dei Conti). See Corte dei Conti (1995). For a comprehensive catalogue of the many inefficiencies hampering Italy's military establishment, also see Nones (1996).

[77] The potential for capital-labor substitution is reduced by the long life span of most capital equipment, however (Warner and Asch, 1995, p.370).

[78] Related studies carried out in other countries are either non-existent or could not be obtained.

on productivity and costs by affecting turnover rates. Each of these effects is discussed below.

Experience and individual productivity

Almost all research on this relationship has focused on how much more output a person with *x* years of service can deliver compared to another individual with *y* YOS. Or, put in elasticity terms, what percentage decrease in junior enlisted personnel can occur while keeping overall output/readiness constant if the number of experienced soldiers is increased by 1%?[79] Albrecht (1979) provided the most comprehensive analysis of such substitution possibilities.[80] The marginal productivity of career personnel was calculated to be from 1.41 to 2.25 times as high as that of junior personnel. Importantly, Albrecht found that the nature of the work determined the productivity returns of experience: *the greater the skill requirement, the higher the relative marginal productivity of careerists (implying a lower elasticity of substitution between junior and senior personnel).*

Moore (1981) employed activity analysis to examine the impact that a change in experience mix has on capability. A CBO study extrapolated Moore's data on completion times for 26 separate groups of commonly-performed tasks in a medium-skill Air Force specialty. The data included the performance of personnel over a full range of YOS. The CBO report presented completion times data by year of service for three task groups deemed as "representative:" periodic inspection, unscheduled maintenance (simple equipment/subsystem), and corrosion control. The data shows that completion times are reduced with length of service, *but the rate of decrease is proportional to the difficulty of the task* (the more difficult the task, the greater the gains over time). The data show that after 10 years of service, the decreases of completion times as a function of YOS diminish steadily and eventually flatten out for all tasks (CBO, 1987, pp. 23-24).

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[79] These studies implicitly hold the equipment stock fixed (Warner and Asch, 1995, p.368).

[80] Originally mentioned in Warner and Asch, (1995, p.368). A portion of section 4.2 is based on studies first summarized by Warner and Asch (1995).

Other studies confirm the positive impact that experience can have on productivity. Marcus (1982) found that the marginal product of the most senior aviation maintenance personnel (E7-E9) was nine times larger of the most junior personnel (E1-E3), and five times that of individuals in the E4-E6 grades.[81] Finally, Hammond and Horowitz (1992) examined how training experience affects pilot productivity, and found that recent training and total career flying time significantly improve pilot performance (Warner and Asch, 1985, p. 369).

Unit productivity

The studies mentioned above show that there could be significant returns to individual experience; however, since most work in the military takes place in a team environment, it is equally important to understand the impact that experience mix has on unit productivity. Doyle (1997) studied the effect of unit experience mix on unit size, and found that when the work mix in an given skill category is adjusted to match the experience mix, units can be staffed with fewer but more experienced soldiers—that is, "[a] more experienced unit will accomplish a given amount of work in less time than a less experienced unit employing the same amount of labor" (Doyle, 1997, p. ix).

That being said, experience imbalances in a unit could hurt productivity. Doyle's findings point to the fact that the work of overly junior units could be hampered by the fact that relatively few career personnel would have to supervise a relatively high number of junior soldiers. By dedicating a larger share of their time to supervision, experienced personnel would be unable to work on the more complex set of tasks, which would instead be assigned to less proficient junior personnel. Overly experienced units also pose problems--in this case, senior individuals would have to perform functions that could easily be completed with less experience, thereby decreasing that individual's effective (rather than potential) productivity. Similar observations in a non-military context were made by McDaniel et al.

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[81] Marcus used a generalized Leontief production function to estimate substitution elasticities. Two-hundred and ninety-two observations on squadron sorties or mission capable rates formed the data set. First cited in Warner and Asch (1985), p. 369.

(1988), who found that the correlation between job performance and job experience is highest for samples with low mean levels of job experience (the correlation drops as the mean level of job experience increases).

The impact of experience mix on turnover and costs

The experience mix can also have an indirect effect on force productivity by affecting turnover rates. A more senior force will have a higher average length of service, and therefore lower turnover rates. In turn, lower turnover rates imply that fewer individuals will be unavailable because of first-year accession training and transit requirements. A smaller training requirement also implies that there will be a reduced demand for trainers, who can contribute to other aspects of the defense mission (Cooper, 1973, p.308). In principle, lower turnover and lower accessions could also help increase quality. When fewer new recruits are needed each year, as would be the case with a more experienced personnel structure, the Army could screen applicants for enlistment more carefully. Higher quality soldiers can have an important impact on effectiveness and costs, as explored in section 4.3.

Lower turnover could also help reduce the costs of a more senior force by placing fewer demands on the recruiting and training infrastructure (Baldwin and Daula, 1984, p.99). And if the relative productivity of career personnel were indeed higher, the incremental costs of seniority such as higher pay and retirement benefits could be balanced by the fact that fewer individuals will need to be employed (Nelson et al., 1974).[82]

Optimal (cost-effective) mixes

Few studies have sought to identify mixes of junior and career personnel that are cost effective. Among these is the research by Gotz and Roll (1979) which derived estimates for three Army and Air Force

[82] On the other hand, the costs of a significantly more senior force could well outweigh the savings reaped through a lower turnover and greater experience, especially if pay and other benefits reserved for career soldiers are greatly superior to those enjoyed by junior personnel. The cost differential would be even more worrisome if the relative productivity of career personnel were not significantly higher than that of more junior soldiers.

specialties ranging from low to high in skill content. They then aggregated these results to produce a single cost-effective ratio for each service (see Table 4.1 for Army results).[83]

Table 4.1 Optimal Junior/Career Mixes for the U.S. Army as estimated by Gotz and Roll (1979)

	Optimal Junior/**Career** Mix
Infantryman (Low skill)	59/**41**
Auto repairman (Medium skill)	52/**48**
Field radio repairman (High skill)	39/**61**
Aggregate	56/**44**

As one would expect, the junior/career mix favors less experienced soldiers in low-skilled occupations, and more experienced soldiers for tasks that instead require greater skill.

Methodological issues

The results reported here should be interpreted with caution for a number of reasons. First, they originated more than two decades ago, and the relationships that were relevant in the 1970s and 1980s may no longer be today given the changes in the nature of military tasks. Second, productivity estimates cannot be easily generalized since they were derived from specialty-specific data--moreover, they should be considered only for experience mixes that resemble the ones used for their estimation. Third, a number of other factors limit the degree to which substantial substitution between junior and career personnel can take place, including: fixed manning requirements (resulting from past decisions on hardware designs), the small numbers of personnel in some work centers,[84] and the limited flexibility of manpower systems in responding to such substitution (CBO, 1987, p.30-34). More fundamentally, the static nature of all the studies mentioned here discounts the fact that in the uncertain and dynamic environment of

[83] This study as well as its results and methodology are originally cited in Warner and Asch (1995), p. 371.

[84] For instance, for a 3-person team, a 10% reduction in total effort given a richer experience mix is not likely to lead to a decrease in the number of personnel employed in that unit.

warfare senior personnel could adjust better given their cross-training and experience (Gotz and Stanton, 1986).[85]

4.3 PRODUCTIVITY AS A FUNCTION OF QUALITY MEASURES

A number of studies also point to a link between quality measures and productivity. In examining the determinants of downtime in U.S. Navy ships, Horowitz and Sherman (1980) found that this measure is reduced as the number of individuals manning the ship with a higher education level and/or higher aptitude scores increases. Several other studies have shown that higher-quality soldiers perform better on the job than their lower-quality counterparts (Scribner et al., 1986, Orvis, Childress and Polich, 1992).[86]

The effect of mental ability on performance appears to have a greater degree of importance as the complexity of the task increases. Orvis, Childress and Polich (1992) found Patriot Missile System operators' performance in simulated air combat increases significantly with mental aptitude. They also discovered that increasing mental aptitude of battery operators equals or exceeds the effect in performance that would have been obtained with additional experience and training (Orvis et al., 1992).

Other studies point to an indirect impact of quality on force effectiveness. High-quality personnel have lower attrition rates during their first enlistment and are promoted more quickly.[87] Since lower attrition and higher promotion rates can positively impact force readiness, one can argue that high-quality personnel make a greater contribution to overall productivity than their lower-quality counterparts (Warner and Asch, 1995).

The impact of quality on costs

Quality's impact on costs can go beyond personnel expenditures--a number of studies have pointed to the fact that hiring more higher-

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[85] Originally cited in Warner and Asch (1995), p.372.

[86] Originally cited by Warner and Asch (1995), p. 370.

[87] See, for instance, Buddin (1988), Buddin et al. (1992), Cooke and Quester (1992), Smith, Sylwester and Villa (1991), and Warner and Solon (1991). These studies were originally cited in Warner and Asch (1995), p. 369.

quality personnel can actually result in lower equipment and training costs. For instance, Daula and Smith (1992) found that the personnel savings resulting from increased reliance on low-quality soldiers in the U.S. Army tank force would be offset by the need to employ more tanks if one wished to maintain readiness levels constant. Orvis et al. (1992) present a similar tradeoff in the case of Patriot missile battery crews. Their experiments indicate that lower quality recruits on average fired two more missiles than higher-quality crews; given that each missile costs in excess of $500,000 (in 1992 dollars), employing higher-quality soldiers is by far the more cost-effective approach. To be sure, the low-quality recruit's performance could be improved with additional training, but this does not consider the fact that the same training resources could be devoted to improving the performance of higher-quality soldiers in order to achieve even greater effectiveness (Orvis et al., 1992).

4.4 FORCE MIX: THE ITALIAN EXPERIENCE

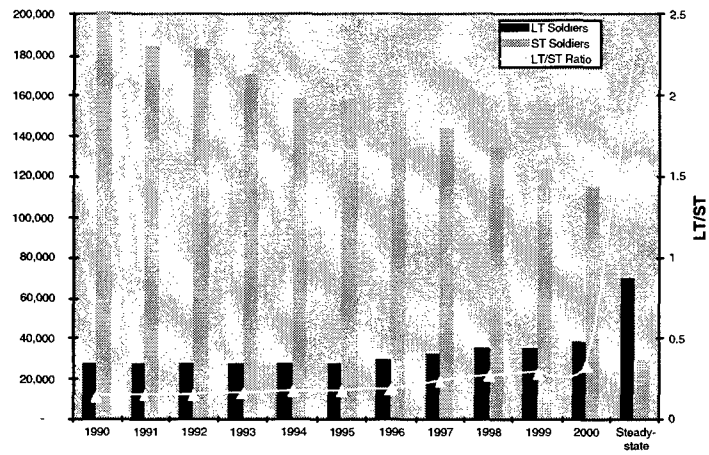
As Italian Army planners consider transitioning to a smaller and fully professional military, they will inevitably be faced with choices on the degree of experience (and quality) the future force should have. The modeling phase will explicitly consider the YOS mix as part of the policy analysis, and this section sets the stage by providing data on past and planned experience mixes, as well as estimates of the current YOS distribution for each personnel category. Since experience mix considerations vary between different occupational categories, available (but limited) data on personnel employment by functional area are also included.

Past and present force mixes

As Figure 4.2 shows, over the last decade the number of soldiers on short-term contracts (conscripts, VFBs and their pre-1996 equivalents) have been slowly declining relative to those who instead served as career enlisted personnel (VSPs, Sergeants, Marshals and their pre-1996 equivalents). According to unofficial Army plans, *the ratio of soldiers on long- to short-term contracts is expected to soar from 0.33 in 2000 to 2.33 in the 2020 steady state.* This means that there will be a

radical shift from having 1 long-term soldier for every 3 short-term soldiers to a system where there will be more than 2 long-term soldiers for every short-term soldier. Clearly Army planners are seeking to create a much more experienced force, in which career enlisted personnel will play a critical role.

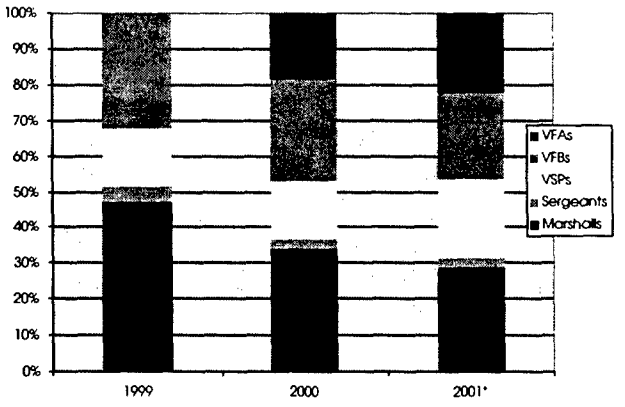
Figure 4.2 Army career vs. short-term mix, 1990-2000 and 2020



source: based on Army General Staff data

The first signs of the shift toward greater reliance on VSPs can be seen in Figure 4.3, which shows the evolution of the Army's volunteers by categories over the last two years, and the projected breakdown for 2001.

Figure 4.3 Personnel categories as % of Army volunteer enlisted/NCO force



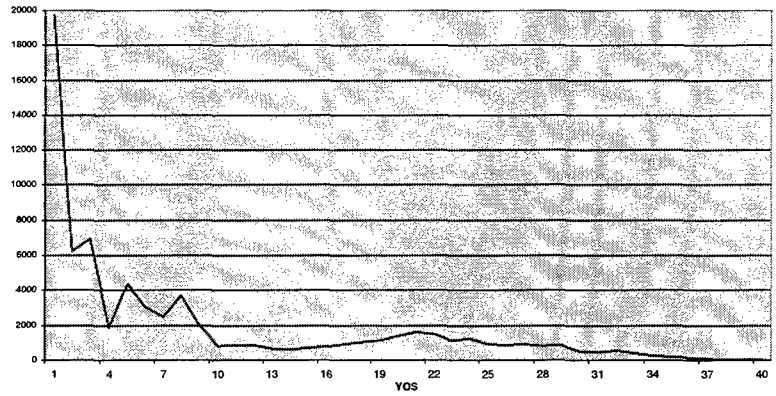
source: based on Army General Staff data

Given the considerable intakes of VFAs, VFBs, and VSPs, the share of the Marshals category has dropped. The VSP stock is destined to grow the most in relative size—indeed, the VSP intake is scheduled to amount to about 7,300 soldiers in 2001, representing a substantial rise from the 2000 level of 12,000. Even assuming a large outflow of VSPs into the Sergeant stock, the planned VSP accessions for 2001 will likely represent more than a one-third increase in VSPs.

Current YOS distributions

This sub-section presents data on YOS distributions for the entire force, and then disaggregates these by category. The YOS distribution was estimated YOS using several (and often discordant) data sets provided by General Staff. The assumptions made for each category are described below.

Figure 4.4 Army enlisted and NCO YOS distribution



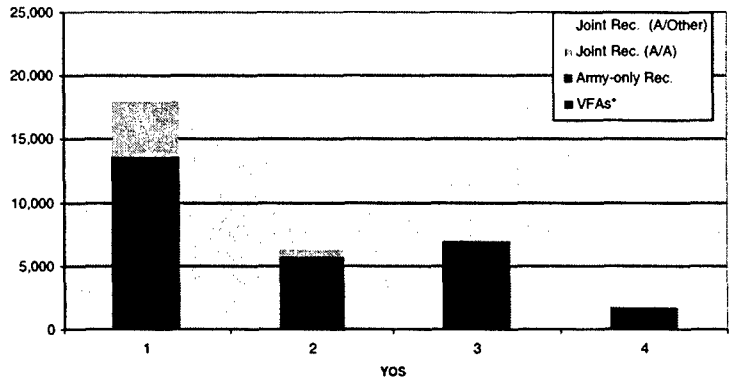
source: based on Army General Staff data

As Figure 4.4 shows, the force appear to be relatively junior. The spike in the first YOS is made up of newly-entered VFBs and a large number of VFAs. The "double hump" at the 4-10 YOS marks is primarily made by VSPs, although some junior NCOs (Sergeants and Marshals) are also included. The other hump (which appears small on an absolute scale) is concentrated in the mid-career NCO force, at around the 19-25 YOS marks. As mentioned before, the total force profile is likely to change considerably as the transition progresses, so one should not interpret the YOS distribution presented in Figure 4.5 as being the desired steady-state, or a description of survival probabilities as individuals progress in their careers.

VFA/VFB

The junior enlisted stocks are made up by VFAs, which cycle through the force every year, and VFBs. The oldest VFBs have 4 years of service (the vast majority of these are awaiting transfer into the VSP stock). Most VFBs have entered the force through the old, Army-specific recruiting channels; only in 2000 did the first sizable contingent of personnel recruited through interservice contests begin service (the ones that took place in 1999—see Figure 4.5). Almost all individuals currently in the VFB stock will be eligible for promotion as VSPs, since those who elected to serve in the military before being transferred to a police force remain a small fraction (and are concentrated in the first YOS).

Figure 4.5 YOS distributions VFA/VFBs[88]



source: based on Army General Staff data

VSP

The data for the VSP stock was more difficult to obtain, since the Army General Staff does not have ready and precise statistics on the YOS of those who entered the career force prior to the mid-1990s. But even under conservative assumptions, the YOS distribution is dominated by junior personnel. Figure 4.6 shows the YOS estimates for the current VSP stock. The planned intake of 7,300 soldiers in 2001 will contribute further toward lowering the average VSP age in the short run, but will have the opposite effect in the medium- to long-run. Figure 4.7 also reveals that a sizable "hump" has been created by admitting into the VSP force a significantly larger number of individuals relative to the steady-state intake.[89] Such intakes took place in order to create a "hard core" of career enlisted soldiers relatively early on during the transition, as well as to increase the promotion opportunities of VFBs.

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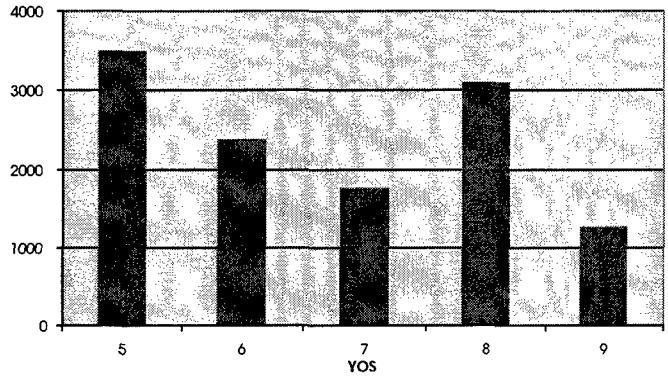
[88] The latest official data on the VFB stock available for this analysis dates back to July 2000. To update the YOS distribution to the end of 2000, it was assumed that those promoted into the VSP stock were promoted first-in-first-out: that is, the promotions as VSP that took place in the second part of the year were subtracted from the VFB totals starting with the oldest VFBs (including those who had sought a renewal). It was also assumed that those entering as VFBs in 2000 have 1 YOS, despite the fact that not all of them entered the force at the beginning of the calendar year.

[89] Assuming that the YOS distribution for VSPs is uniform and that the average career length is 30 years in this category, one would expect an inflow of about 1,500 people per year (this equals the steady-state outflow).

Figure 4.6 YOS Distribution: VSPs[90]



source: based on Army General Staff data

NCOs

The picture for NCOs is significantly different. While the Sergeants stock is nearly empty, professional Marshals have been serving for decades. In fact, this category has a high concentration of soldiers in the mid-career phase.

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[90] Following the advice of Army database managers, those entering as VSPs in 2000 were assumed to have 5 YOS: there is a significant lead-time between selection through the contest and actual transfer to a VSP unit (an individual who has completed his/her third YOS as VFB would likely have to serve another year in that stock before obtaining the promotion to VSP). A similar lead time exists for those who are promoted from VSP to Sergeants--those who have been selected to become Sergeants but who have yet to be transferred to active-duty NCO positions were counted as VSPs. The maximum YOS for this stock was assumed to be 9; this implies that individuals that entered in 1996 were at that time beginning their fifth YOS.

Figure 4.7 YOS Distribution: NCOs

source: based on Army General Staff data

Figure 4.7 shows such "hump" going from the 19th to the 25th YOS. The bulk of the individuals in the hump are concentrated in the M3 and M4 grades. This abnormal concentration of personnel in the space of a few YOS was created through unusually large numbers of promotions from the lower ranks.[91]

Occupational mix

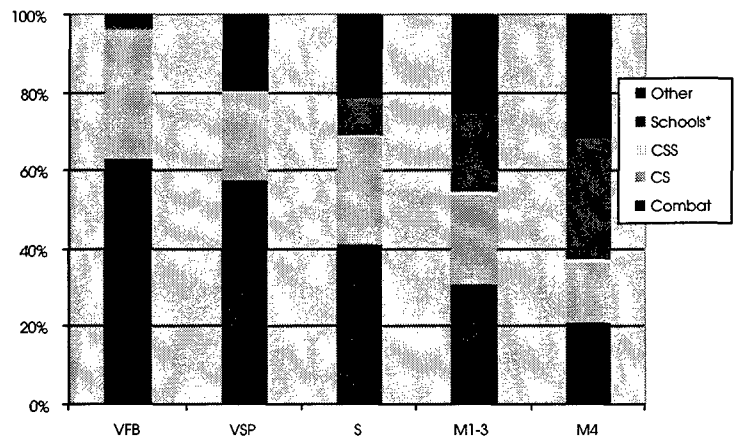
Only limited data on occupational specialties and skills among the force could be gathered during the research effort. What follows is a brief description of currently available information.

Figure 4.8 shows the employment of enlisted and NCO personnel in functional specialties—including combat, combat support (CS), combat service support (CSS), and schools/training. It shows that the proportion of individuals serving in combat and CS specialties decreases with the seniority of the personnel category. This is mainly a function of age—Army planners allocate young personnel to those tasks that require vigor and a high degree of physical fitness. An interesting phenomenon shown by this chart is that there is a very small number of personnel actually dedicated to CSS tasks—in fact, these activities are currently been undertaken by conscripts. The occupational breakdown for

[91] Part of the problem was created in the mid-1990s, when soon after the passage of a new personnel law, many of those employed on a long-term basis (but who were considered too senior to become VSPs) were automatically promoted as Marshals.

the VSP category is likely to change significantly in the future, however. According to Army planners, mid-career VSPs will gradually be transferred from combat assignments and allocated to support/administrative functions.

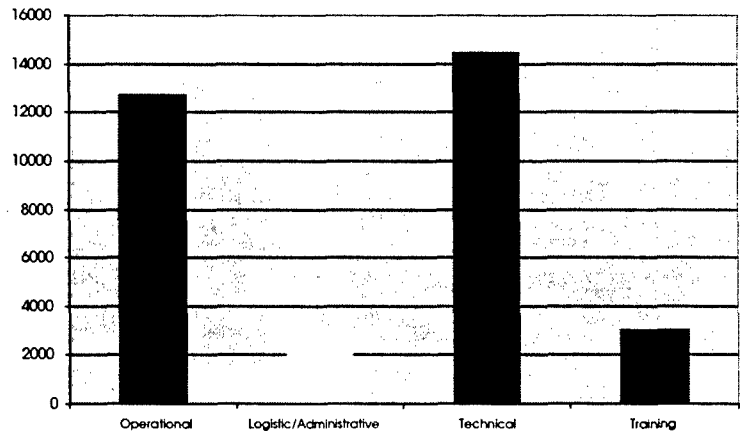
Figure 4.8 Functional specialties: share by personnel category



source: based on Army General Staff data

The final occupational chart provides additional data on the specialization within the VFB and VSP stocks. It shows that the vast majority of the enlisted force is either performing operational or technical tasks; very few of them are dedicated to logistical/administrative duties, and even fewer to the training establishment. This is consistent with Figure 4.8; the relatively large number of individuals in training functions is directly related to the requirements of a conscript military.

Figure 4.9 Additional data on VSP/VFB specialization



source: based on Army General Staff data

4.5 FORCE MIX: KEY ISSUES

The determination of manpower demand—choosing how many individuals are needed in the Army, how experienced they should be (either by grade or YOS) and what of occupation or skill should be emphasized—is possibly the most difficult question facing manpower planners (Kirby and Thie, 1996, p.25). Having said that, the foregoing discussion highlights a series of critical and policy-relevant points:

- Several studies have shown that productivity does indeed rise with years of service; they also indicate that the actual returns to experience vary significantly according to the type of occupation or skill;[92]
- The relationship between rising YOS and rising productivity is by no means automatic. In fact, actual unit productivity may be lower than potential productivity in cases where the experience mix is either overly skewed towards junior or senior personnel;
- While most research has focused on tradeoffs between first- and second-term personnel, it is plausible that Moore's (1981) results

[92] Related to this, the costs to the organization of employee separation also change considerably according to skill set and occupational category.

can be generalized: that is, returns to experience diminish the easier is the skill set, and the longer the years spent working on that task.

- Quality can to some extent substitute for experience (and vice-versa), and should be considered when making tradeoffs because of its potentially high impact on productivity and costs.

These findings are particularly relevant for the Italian Army, since it is beginning a transition to what by all accounts appears to be a much more senior force than today's, especially in the enlisted ranks. As was first mentioned in Chapter 3, Army planners have yet to face the full impact of many of the tradeoffs they are making today. Decisions on the experience mix, and the allocation of individuals to different occupational categories based on their experience, have not generated great stress in part because the force remains relatively young: volunteers are in combat or combat-related positions, and conscripts are being staffed in support and administrative positions. But stresses and pitfalls on these fronts could also emerge in the future. Three potentially problematic issues are particularly relevant:

- The Marshals category could face significant experience mix imbalances before 2020;
- Increasing the stock of VSPs will diminish yearly VFB accession requirements, but it raises a host of unresolved issues (especially in terms of occupational/skill assignments);
- Personnel characteristics such as quality are under-investigated yet important issues for Army manpower planning.

These are briefly discussed below, and are further explored in the following chapters.

The Marshals category could face significant experience mix problems

Were the spike shown in Figure 4.9 to be a permanent wave that will continue to affect the stock until most individuals in it reach the retirement age at around 37 YOS, it would be a cause of concern. Over

time, such imbalance would lead to a progressively more senior NCO force, potentially blocking further inflows into this category. In fact, inflows have already been reduced to a trickle: the 2000 Marshals contest made 210 slots available, out of a total stock size of approximately 27,000. To make it worse, many of those in the "hump" are concentrated in the M3 and M4 categories, implying that such individuals will have to remain in the terminal grade for a considerable portion of their career (thus putting to the test the potential shortcomings of the compensation and promotion systems, as discussed in Chapter 3).

The lack of new entrants also has an impact on the skill distribution of the Marshals category. A new Army plan is seeking to transform soldiers in the Marshals grade as both operational commanders (of platoons) and highly skilled technical workers. However, during conversations with Army officials it has become apparent that it will be difficult to retrain relatively senior Marshals in either of the new specialties. Therefore, a very senior Marshal stock may hamper plans to alter the distribution of skills and occupations in the force.

Increasing the stock of VSPs will diminish yearly VFB accession requirements, but it raises a host of unresolved issues

One advantage of a more experienced enlisted force is the reduction in personnel turnover at the junior ranks. This could facilitate the tasks of the recruiting establishment, lower training costs, and possibly add greater predictability to the manpower planning process. To be sure, the benefits also include a potentially more productive and cross-trained force.

It is difficult to confirm that the benefits of a more senior VSP force will be worth the additional costs, however. Such costs not only include higher pay and additional entitlements given to career soldiers, but also the inflexibility introduced in the personnel system by hiring individuals virtually for life. Opportunity costs could also be significant were senior VSP personnel assigned to tasks for which experience does not produce a significant return—a real possibility if VSPs will be used as substitutes for conscripts in support/administrative functions once they reach the mid-career point.

Another set of factors could further exacerbate the potential problem, and reverberate through the system for decades. By the end of 2001, nearly 20,000 soldiers will be in the VSP stock with a range of years-in-stock going from 1 to 5. This means that 44% of the steady-state level of soldiers (45,000) is be concentrated in 17% of the projected years one could spend as a VSP (30). To be sure, some of these individuals will exit the stock via natural attrition or promotion into the NCO ranks, but the threat of a hump in the latter years is real. A long-lived spike could have deleterious effects on personnel management and even overall force productivity, especially if the work intended for older VSPs does not necessarily require much experience to be performed satisfactorily, and if the groups of soldiers in such a spike prove to be of inferior quality.

Personnel characteristics such as quality are under-investigated yet important issues for Army manpower planning

The previous and current chapters have underscored the importance of quality and occupational assignments in determining personnel productivity and cost. Yet the manpower planning process does not seem to be placing enough weight on this and other relevant individual characteristics. More attention is being placed on the need to meet short-term numerical targets, without fully exploring the impact that these actions will have on the composition of the force in the long run. The VSP promotion policy is a case in point: promotions into this category during the last six years have virtually been open to all of those who were willing to join. This could be particularly problematic given that the initial entry requirements for these cohorts were not necessarily selective enough, and that VSPs will serve in the force for decades.

PART 2: MODEL-BASED POLICY ANALYSIS

5. A METHODOLOGY FOR THE MODEL-BASED ANALYSIS

This chapter discusses the methodology that guides the model-based analysis portion of the dissertation. Following Quade (1989), it closely considers four basic elements of policy analysis: the objectives, the alternatives, the impacts, and the criteria. The last element of Quade's framework--the model--is thoroughly discussed in Chapter 6. As described in the following sections, the methodology articulates a multi-attribute utility approach, borrowing on the work of Hillestad and Davis (1998) and Thie et al. (2001). The substance of this chapter also draws heavily from the findings and hypotheses highlighted in the preceding four.

5.1 OBJECTIVES: PURPOSE AND SCOPE OF THE ANALYSIS

The basic analytical goal is to help the Italian Army identify the transition path--and the associated sequence of decisions--that is most likely to lead to a *balanced* enlisted and NCO force, taking costs directly into account. As discussed below, the "balanced force" concept is related to whether personnel are appropriately distributed by grade/category and year of service. The simulation model is used to identify alternative strategies for attaining this fundamental objective, with the additional requirement that the force should by 2020 reach the steady-state mix of 30,000 VFBs, 45,000 VSPs, 10,000 Sergeants, and 15,000 Marshals.

Examining the degree to which different strategies bring about a balanced force over time is critical for several reasons. For instance, abnormally large concentrations of personnel in certain grades or in a small set of years of service make force management difficult--promotion bottlenecks would most likely ensue, negatively affecting career opportunities. In turn, this could have a direct impact on effort supply and on the quality of personnel that chooses the military profession, as

mentioned in Chapters 2 and 3.[93] Imbalances could also have an impact on personnel productivity and on the skill mix: Chapter 4 suggests that unit productivity may be lower than potential productivity in cases where the experience mix is largely skewed toward junior or senior personnel. Past research also indicates that the returns to experience may be limited in those cases where soldiers conduct low-skilled activities. An excessively senior (or junior) force, therefore, could lead to significant experience and skill mismatches, which in turn would have a debilitating impact on overall effectiveness. Finally, to the extent that personnel costs vary according to years of service, large concentrations in career-track cohorts could also have a significant cost impact.

Identifying subordinate--and more precise--objectives

How can one assess the degree of force balance? Indeed, such a concept could by its very nature be measured in several ways. A number of subordinate objectives can add specificity and facilitate the process of evaluating whether particular policy options lead to different degrees of "balance". Taking the findings from the previous chapters and the priorities of Army planners into account, four specific objectives stand out as particularly relevant:[94]

- *YOS balance*: minimize the spikes in the YOS distribution relative to a target profile, and their concentration in particular age groups;
- *Promotion opportunities*: promote individuals at an acceptable rate;
- *Terminal grade share of category*: limit the number of individuals in the terminal grade for each category (e.g., VSP4's share of the VSP stock);
- *Distance from the steady-state*: minimize the distance between the actual and steady-state force mixes during the transition.

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[93] Personnel humps and valleys would also prove disruptive to other personnel management processes, such as training and occupational assignment.

[94] Other specific objectives could be identified and examined by this analysis. However, the ones presented here appear to be both relevant for and sufficient in capturing the essence of the broader objective.

The first objective is directly concerned with YOS imbalances--the goal is to avoid or reduce disruptive humps or valleys in the experience distribution of the force, especially when such imbalances are concentrated in particular age categories (that is, when they are not evenly distributed throughout the relevant YOS range). The second objective instead specifies that opportunities for promotions should conform to an ideal or target rate, reflecting the assumption that promotion opportunities should neither be too high nor too low. Related to this is the third objective, which underscores the potential effort supply, skill matching, and productivity problems that would arise from having an overly large number of individuals in the terminal grade of each category. The final objective instead highlights the fact that, at any time during the transition, being closer to the steady-state objective is "better" than being father away, *ceteris paribus*.

In essence, all objectives articulate a set of goals for different aspects of force balance. The outcomes of alternative transition strategies are compared to such targets in order to assess their performance. The procedure for identifying alternative strategies is illustrated in the following section; the methodology for measuring these objectives and comparing outcomes is detailed in sections 5.3 to 5.5.

5.2 ALTERNATIVE STRATEGIES

Identifying alternatives that most closely attain the force balance objectives is one of the core tasks of the model-based analysis. These alternatives are essentially different sets of policy interventions to be implemented during the transition out to 2020 and beyond. These mixes can easily be altered in the simulation model, since the user can manipulate a set of levers that (1) have been included in similar efforts in the past, such as attrition and retirement timing and/or (2) are identified by the government and military personnel regulations as explicit policy variables, such as the number of individuals selected for the career force every year. Table 5.1 includes a list of policy levers that are particularly relevant for each personnel category.

Table 5.1 Policy levers

Junior Enlisted (VFAs/VFBs)

- Attrition
- % of individuals renewing
- % of individuals exiting the force at the end of their term (to police forces and civilian world)
- % of VFAs able to become VFBs
- Number of individuals recruited each year as VFBs/VFAs

Career Enlisted/Sergeants

- Attrition
- % of individuals selected for career force
- S1 slots: as a % of the VSP2, VSP3, VSP4 stock
- VSP2&3/VSP4 share of S1 slots
- Retirement age/probability

Marshals

- Attrition
- Retirement age/probability
- Number of individuals who enter the terminal M4 grade:
- -Through the competitive process before 8 years in the M4 grade
- -At the end of 8 years in the M3 grade
- Number of individuals selected from VSPs and Sergeants category
- VSP/Sergeants share of Marshals slots
- Number of lateral entrants

As explained in Chapter 7, the default set of values for these levers was specified either by official Army policy, or with the advice of several Army planners. Running the model with default values essentially produces a "base case" estimate of how the Army personnel system would behave over time in the absence of additional interventions. The base case scenario (also illustrated in Chapter 7) serves as a useful reference point when considering alternative strategies (Walker, 1978).

Constructing and screening the alternatives

The process of creating and screening alternatives is especially critical when using a simulation that generates a large set of runs (Quade, 1982, p. 129). To strike a balance between the infinite number of potential policy lever variations and the need to produce useful and timely results, strategy creation and screening were undertaken using a two-phase "search" process.

Stage 1: First-level screening of policy levers

In the first phase of the search process, the leverage of each policy variable is tested by parametrically changing its values in multiple runs, and by verifying the impact of such changes on model outcomes. Since it is unlikely that all variables will have high leverage over the behavior of the system, one should be able to identify which individual policies show the greatest potential for shaping outcomes and meeting the objectives.

Stage 2: Combining the levers to craft alternative strategies

The high-leverage policy levers identified in stage 1 are then combined to construct full-fledged strategies. The combinations simultaneously vary several parameters, as well as the timing of such variations during the simulation. Even with a smaller set of policy variables, it is still be impossible to undertake an fully exhaustive optimization, or a full exploration of all potential permutations. Having said that, by the end of the second stage a large number of alternatives will have been explored, and from these it will be possible to focus on a smaller number of interesting ones (Quade, 1982, p. 134).[95] The shortlist will then be scrutinized more closely, especially in terms of the outcomes (or *impacts*) they bring about (see section 5.3).

The choice of policy levers and the determination of a model boundary

As one can infer from the policy levers listed in Table 5.1, most of the analysis revolves around changing the policymaker's decision rules. Individual responses to these changes, measured by variation in behaviors such as enlistment, re-enlistment, and effort supply, are not

[95] Quade writes that "[o]nce can always think of trivial ways of modifying an existing alternative to obtain an entirely new variant. But it is also obvious that at some stage it may clearly not be worthwhile to do so; although differences may exist, they may be so insignificant that, within the precision of our model or of our data, their effect on the benefits or costs cannot be distinguished from previously considered alternatives. Moreover, many will be obviously dominated by others--that is, another alternative can be found that is better in some aspect (say, lower cost) but equally good in all other aspects" (Quade, 1982, p.129).

explicitly modeled. Recruitment and other processes are treated as *exogenous*--that is, they can be changed parametrically, but they will not depend on individual responses to policy levers such as entry pay, advertising, and number of recruiters. This approach also implies that potential behavioral feedback effects (e.g., reduced enlistments resulting from reduced promotion opportunities into the career force) will not be included.

This decision can be justified on two main counts. Firstly, while looking at all aspects of a problem may be ideal, it is impossible in practice: "[t]o perform analysis, some considerations, usually many considerations, must always be left out" (Quade, 1982, p. 49). Only certain parts of a given problem can be explored in detail, and that while this approach is by definition incomplete, it can nonetheless identify strategies that constitute improvements over the current situation. Secondly, the decision to exclude behavioral effects is heavily affected by the uncertainty that surrounds such effects--especially their magnitude and their sensitivity.[96] For behavioral impacts to be faithfully represented in the model, one would need to understand in much greater detail how individual behavior would be impacted by different policy changes. More information is needed on responses to changes in pay, promotion opportunities, and how such responses would vary according to personnel characteristics such as quality. These data can only be obtained using thorough econometric analyses or experiments, which constitute sizable research endeavors in and of themselves.

5.3 IMPACTS: ESTABLISHING THE MEASURES OF EFFECTIVENESS AND COST

Simply put, the impacts are the consequences of each strategy. The model gauges a strategy's impact by reporting outcomes for a set of measures of effectiveness (and cost) at each time period. The measures of effectiveness are directly linked to the four specific objectives mentioned in the first section of this chapter (see Figure 5.1).

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[96] Indeed, the specification of which variables to exclude or to assume as exogenous should take into account the data and knowledge that exists on the policy issue under review (Quade, 1982).

Figure 5.1 Aggregate and specific measures of effectiveness

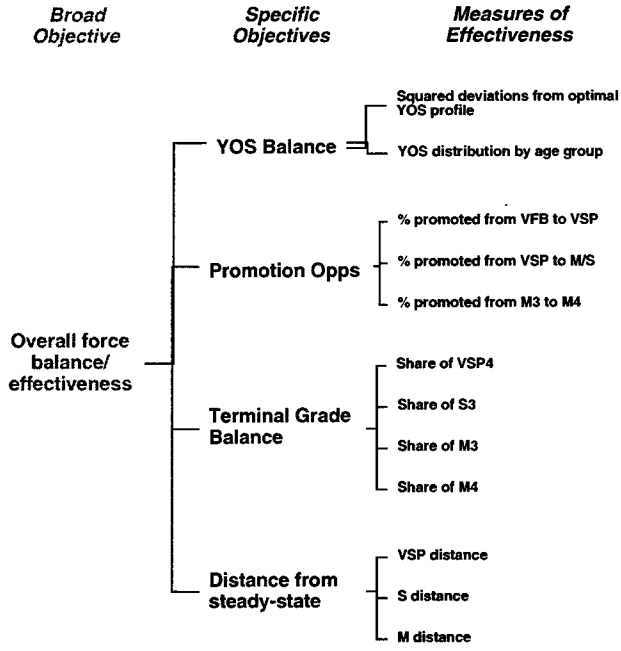

Figure 5.1 shows that the attainment of the specific objectives is assessed with more than one measure--for instance, promotion opportunities are reported for junior enlisted personnel seeking to enter the career enlisted force, and for career enlisted personnel seeking to enter the NCO force. This approach enables a more precise reading of performance of the system in different sectors; it also makes the assessment of performance easier, since the Army usually sets targets at the category and grade levels.

Each measures of effectiveness is described below; the last sub-section includes a discussion of cost measures.

YOS balance measures

Two specific measures are used to capture YOS balance: (1) average squared deviations from a target YOS distribution, and (2) the share of "young" and "old" soldiers in the career force.

Average squared deviations from a target YOS distribution

YOS imbalances can be quantified by measuring the average squared deviations of an actual YOS distribution from a target distribution.[97]

[97] Section 5.4 describes how the ideal distribution is derived.

The process of calculating averaged squared deviations is relatively simple--for each relevant YOS, the square of difference between the actual and target distributions is computed; these deviations are then averaged over the applicable YOS range. Formally,

$$AvgSqDev = \frac{\sum(X^a_i - X^t_i)^2}{n} \qquad (5.1)$$

where X^a_i is the actual number of individuals in YOS i, X^t_i is the target number of individuals, and n is the range of YOS considered in the calculation. For instance, assume that an "ideal" distribution for 3 years of service is of 100 soldiers in YOS 1, 50 in YOS 2, and 25 in YOS 3. Assume further than in a particular year of the simulation, the actual profile is of 50 in YOS1, 100 in YOS 2, and 25 in YOS 3. Then the averaged squared deviation for that particular actual profile for that year is of 1,667, as show in Table 5.2.

Table 5.2 Sample Calculation of Averaged Squared Deviations

YOS	Ideal Profile	Actual Profile, Year *t*	Squared Deviation	Average Squared Deviations, Year *t*
1	100	50	2,500	
2	50	100	2,500	
3	25	25	0	
				1,667

Averaged squared deviations provide a single-point estimate of the degree to which unusual humps and valleys affect the YOS distribution in a given year. Out of all the measures of effectiveness considered in this analysis, this represents the only case where deviations from an ideal or target case are squared--reflecting the assumption that larger imbalances are disproportionately more disruptive than smaller ones. Such assumption is in line with the opinion of most Army planners that were interviewed. It is also important to recognize that the number by itself has little meaning; however, it becomes useful when these values are compared across time periods and across alternative strategies (see section 5.4).

Career force distribution by age group

Average squared deviations gauge "spikeness," but do not provide much information of how concentrations of personnel are distributed across the force. It is conceivable that two YOS distributions could have very similar averaged squared deviation scores but very different personnel management implications. To take such a possibility into account, this set of measures calculates the share of two arbitrarily-defined age groups (young and old) as a percentage of the total. Large deviations from the target share would be symptomatic of either peaks or valleys in specific portions of the YOS distribution.

Promotion opportunities measures

Promotion opportunities are assessed for those seeking to transition from the VFB to the VSP category, from the VSP to the NCO categories, and from the M3 grade to the Marshals' terminal grade, M4.[98] For each, this is computed as the number of promotions divided by all those eligible for promotion. Other promotions that take place in the system are not considered since they rely on automatic time-in-grade rules.

Career force terminal grade share measures

The share of career force terminal grades is simply obtained by dividing the size of each terminal grade (e.g., VSP4) by the size of the corresponding category (VSP). Other terminal grades whose share is gauged for every year of the simulation include S3, M3, and M4. The share of the M3 grade is included because access to the M4 grade as a M3 is regulated with a yearly contest (see Chapter 3).

Distance from the steady state criteria

This measure calculates the numerical distance between the steady-state force structure by category (VFB, VSP, Sergeants, Marshals) and the actual size of each category. The distance is measured for every time period of the simulation.

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[98] Sergeant promotions to Marshals are likely to be extremely low under most reasonable assumptions, and were therefore not included as a separate measure of effectiveness.

Cost measures

The model calculates the yearly cost (in constant 2001 Liras) of the active-duty force as a function of grade and years of service. Active-duty costs are derived from the Italian Army's pay tables, and include basic pay as well as the additional allowances discussed in Chapter 3. The incremental costs of eventual early separation programs are also calculated.[99] Such cost has to be approximated, since early separation policies have never been implemented by the Italian military. A suitable potential benchmark comes from the U.S., where during the drawdown of the 1990s personnel were offered early separation incentives. The more popular of these was the Special Separation Benefit (SSB), which consisted of a one-time lump sum equal to 15 percent of basic pay multiplied by years of service.[100]

Given the considerable lack of uncertainty, the analysis assumes that the Army will manage eventual early separations by offering a SSB-like lump sum of either 15% or 30% of *maximum pay* times YOS. These are likely to be conservative cost assumptions, but such conservatism is warranted in light of the uncertainty surrounding this estimate.

5.4 GAUGING EFFECTIVENESS AND COST USING CRITERIA

A criterion is "a rule of standard by which to rank the alternatives in the extent to which they achieve one or more objectives. As such, it provides a way to relate objectives, alternatives, and impacts" Quade, 1982, p. 47). Each measure of effectiveness discussed above is accompanied by a target quantity, and strategies are compared according to how far they deviate from such target. Some of these

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[99] Retirement costs are instead excluded from the calculation. The model does not also include other cost impacts such as training and equipment costs as functions of the experience mix. To be sure, the total cost impact of different strategies could vary in significant ways, but assessing total costs is a complicated enough endeavor to deserve a separate long-term study. Qualitative assessments of how such the total costs could be affected by different strategies total costs are made where appropriate.

[100] The other early separation program, called the Voluntary Separation Incentive (VSI), offered personnel an annuity payable for 2 times their years of service equal to 2.5 percent times basic pay times YOS. Both the SSB and VSI required affiliation with a reserve component. See Asch and Warner (2001).

targets can be easily deduced from government plans (e.g., the steady-state category mix); others instead have to be obtained from expert opinion within the Army General Staff.[101] Given that the model will produce results for several time periods, criteria need to account for the fact that a strategy's performance on a given measure may differ significantly over time. What follows is a first description of the criteria that are employed for each measure of effectiveness and cost; these are further elaborated in Chapter 8.

YOS balance criteria

Average squared deviations criteria

The target YOS profile serves as the yardstick for the "spikeness" of the actual experience distribution. Such profile essentially assumes a uniform distribution of personnel for each category (or group of categories in the case of VSP and Sergeants). For example, if the VFB stock is composed of 30,000 soldiers and the length of the term is 5 years, then there should be approximately 6,000 VFBs in each YOS slot (1 through 5). Following a similar logic, Figure 5.2 below provides a rough approximation of the target YOS distribution for the enlisted (VFB and VSP) and Sergeant force, using the Army's size goals for each category in the steady-state.

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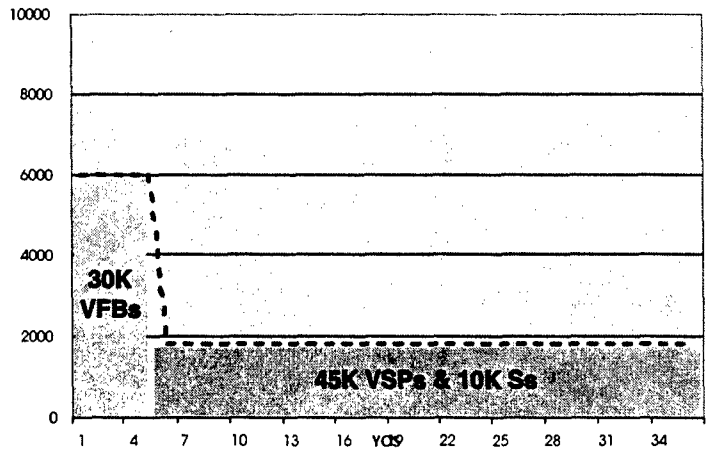
[101] The frame of reference for the evaluation of all measures of effectiveness is the government plan. That is, the analysis focuses primarily on how the Army could reach its steady state objectives in a way that maintains force balance--and not on whether the Army steady-state objective is "optimal." Evaluating different steady-states goes beyond the scope of this dissertation, since it would constitute a sizable effort in and of itself. That being said, the set of outcomes obtained from this analysis could certainly inform policy makers' judgments on the suitability of the current steady-state category mix (see Chapter 9).

Figure 5.2 VFBs to Marshals: Approximation of target YOS profile for VFBs, VSPs and Sergeants



It is important to note that these stylized profiles do not necessarily reflect the Army's expectations of what the experience distribution *should be*, especially if one takes into account the fact that (1) individuals can be promoted to other categories (e.g., Marshals), and (2) personnel at every YOS leaves as a result of attrition.[102] At the same time, however, they complement other measures of force balance by signaling the presence of abnormal personnel concentrations. The persistence of such concentrations over time is gauged by recording performance at different time intervals.[103]

Career force distribution by age group

For this measure of effectiveness, outcomes are judged according to the deviation between the actual share of "old" and "young" career personnel is compared to a target value (see Chapter 8 for a discussion of these and other target values). Deviations from the target are

[102] Nor do they necessarily constitute an ideal profile in terms of force readiness and productivity. As mentioned before, it is impossible at this stage to precisely ascertain what would be the "optimal" experience and grade mix.

[103] Estimates of average squared deviations will also take into account the fact that the VSP and Sergeants categories will not have a full YOS distribution until the very last years of the simulation, since they begin the transition exclusively with young personnel. For these categories, those deviations resulting from the lack of personnel beyond the age of the oldest cohort will not be included. See Chapter 8 for more details.

assessed at different times by averaging them over time periods (e.g. 2001 to 2010, 2011 to 2020, and 2021 to 2030).

Promotion and terminal grade criteria

Strategies are also evaluated according to their deviation--either negative or positive--from a set of promotion targets derived with the help of expert opinion. For instance, the Italian Army wishes to promote a third of each eligible VFB cohort into the career force every year; values significantly lower than 33% signal an excessive tightening of standards, while higher rates indicate a loose promotion policy. Similarly to prior criteria, performance is assessed over different intervals.

Distance from the steady-state criteria

The numerical distance of each strategy from the steady-state personnel mix is easy to compute, since the Army has clearly specified what such mix should be from 2020 onwards. The strategies are then compared on their deviation from the steady-state over time.

Cost criteria

The model computes active-duty costs and early separation costs for each year. The simulation then generates a 30-year cost stream, which is evaluated in terms of its Net Present Value (NPV). Formally,

$$NPV_{costs} = \sum_{t=1}^{30} \frac{Costs_t}{(1+r)^t} \qquad (5.2)$$

where r is the discount rate. The discount factor used is 3.5%, or roughly the net yield of an Italian 30-year Treasury bond. The debate on which discount rate should be used to evaluate government programs has been raging in the economics literature for decades. However, several sources indicate that analyses involving constant costs should use the real Treasury borrowing rate on marketable securities of comparable maturity to the period of analysis.[104] The nominal yield on an 30-year Italian Treasury bond was 6.09% in May 2001 (Blooomberg.com,

[104] See, for instance, Circular No. A-94, "Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs," October 29, 1992.

2001). One obtains the 3.5% discount rate by subtracting from the nominal yield the current inflation rate which was estimated at approximately 2.5% (Economist Intelligence Unit, 2000). To measure the sensitivity of the results to these assumptions, alternative NPV calculations were made using a range of discount rates.

5.5 COMPARING THE ALTERNATIVES: A SCORECARD APPROACH

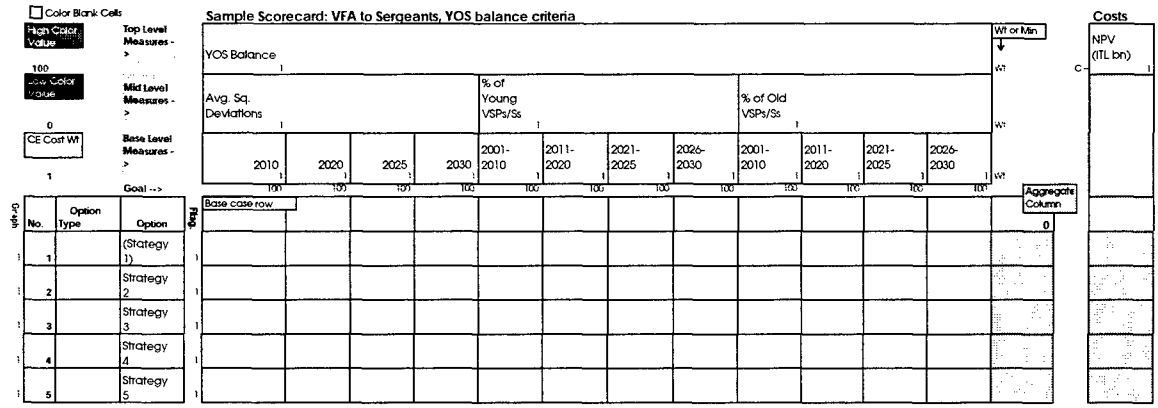
The process of comparing strategies is seemingly problematic, since there is no way simple way of ranking the alternatives. Indeed, there are multiple measures of effectiveness over several time periods, often measuring outcomes with different scales. The analysis is also complicated by the fact that policy makers are likely to differ on the amount of emphasis placed on each measure--some may be more concerned with short-term impacts on effectiveness, while others may instead worry about the long-term costs of each strategy.

These potential problems can be addressed by adopting a multi-attribute utility approach, whereby effectiveness is disaggregated into several factors which are then weighted according to a given set of preferences (Keeney and Raiffa, 1993). The *Dynarank* decision support tool provides an intuitive way to present the results of policy analyses based on a multi-attribute utility approach (Hillestad and Davis, 1998). Dynarank displays the alternative strategies in rows, and the criteria against which the options are to be measured in columns. The intersection of the rows and columns contains the evaluation or score of each option against each measure. In turn, these scores are weighted to reflect policy makers' preferences. The weighted average of all scores produces a measure of aggregate effectiveness.

As discussed in the previous sections, total effectiveness is a function of subordinate and more precise measures. The scorecard reflects this hierarchical approach, and employs three distinct "layers" of effectiveness. The *top level* consists of the four specific objectives discussed in section 5.1: YOS balance, promotion opportunities, terminal grade share, and distance from steady-state. The *mid-level* is composed of the measures of effectiveness corresponding to each specific objective (as discussed in section 5.3), while the *base-level* represents

the performance of the measure of effectiveness over different time intervals. Figure 5.3 shows the structure of the scorecard--for ease of exposition, only the first top-level measure and those mid-level measures pertaining to enlisted personnel are included (see Chapter 9 for more details and actual scorecard output).

Figure 5.3 Sample scorecard



Each criteria contains a weight (which is initialized to 1.0 across the board). The aggregate-value column represents the product of the normalized weights on each measure multiplied by the corresponding effectiveness and summed.[105] For every higher-level measure, therefore, aggregate effectiveness can be expressed as follows:

$$AE(x_1, x_2, \ldots, x_n) = \sum_{i=1}^{n} w_i(x_i)$$

$$\textit{where} \qquad (5.3)$$

$$\sum_{i=1}^{n} w_i = 1$$

In equation 5.3, AE stands for aggregate effectiveness, x_1 to x_n are the subordinate measures of effectiveness, and w is weight attached to each measure. At the most aggregate level, this expression represents an estimate of total effectiveness, or overall force "balance." Costs

[105] Weights are normalized when used so that weights of 1.0, 2.0, and 1.0 across a set of three measures would actually be transformed to 0.25, 0.5, and 0.25 when used to multiply the option values. See Hillestad and Davis (1998).

are included on the right-hand side of Figure 5.2. With both measures of cost and effectiveness for each strategy, it is possible to rank alternatives by effectiveness, cost, and cost-effectiveness.[106]

Using the scorecards to rank options

Aggregate effectiveness is a function of the "score" for each criteria and the weight placed on each. Given the multiple scales adopted for the different measures of effectiveness, the scores need to be standardized on a common scale--the one adopted for this analysis has a minimum of 1 (representing the poorest) and a maximum of a 100 (representing the ideal outcome). To convert raw model results to this scale, the following normalization function is used:

$$100 - \frac{|Actual\_Outcome - Ideal\_Outcome|}{|Ideal\_Outcome - Worst\_Outcome| / 99} \qquad (5.4)$$

Equation 5.4 takes the absolute value of the difference between the actual result for a given strategy on a given measure and the target value for that measure. This is the divided by the absolute value of the difference between the target value and the value of the worst-performing strategy (which is itself divided by 99 to normalize the range); the entire expression is then subtracted from 100. The normalization function guarantees that for each measure the worst strategy will be assigned the value of 1; it does not guarantee, however, that the best will receive the perfect score (in fact, even the best strategy can be a poor performer on an absolute level).

This index produces a linear scale, as shown in Table 5.3.

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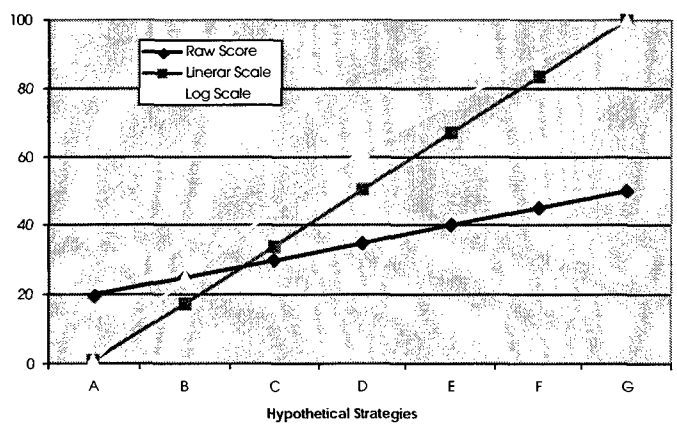
[106] Equation 5.3 is essentially an additive value function (Keeney and Raiffa: 1993). This assumes that objectives can be formulated in a way that guarantees their preferential independence. Such assumption is legitimate given the purpose of the analysis. Indeed, Hillestad and Davis argue that this approach is warranted since Dynarank "is for exploratory and screening analysis of options which ultimately may need to be examined in considerably more depth with respect to outcomes, costs, combinations with other options, etc." (Hillestad and David, 1998).

Table 5.3 Raw vs. scaled scores for a hypothetical target and set of strategies

	Raw Ideal Outcome:	*50*
Strategies	Raw Score	Scaled Score
A	20	1
B	25	17.5
C	30	34
D	35	50.5
E	40	67
F	45	83.5
G	50	100

Other scaling approaches were considered, including the log-log format used in the United Nation's Human Development Report (UNDP, 1999). This format would have boosted the scores of strategies in the middle of the range (shown in Figure 5.4) and by doing so, it would have lowered the relative performance of strategies at the extremes of the score distribution. However, the log-log method proves unfeasible when the target value is zero, as in the case of those measures gauging deviation from the ideal YOS profile and the planned steady-state. Moreover, in most cases where it was possible to observe the impact of the alternative scaling function, results did not substantially deviate from those obtained with a linear approach.

Figure 5.4 The impact of using different scaling functions



To be sure, the impact of each score and therefore aggregate performance depends on the weights placed on each criteria, and for each layer of effectiveness. It is plausible, for instance, that some

strategies ranking near the top under one set of assumption would fare poorly in another. Given the subjective and abstract nature of weights, there is no attempt to seek a definitively "right" set of weights, but rather to explore how different assumptions and weightings affect the relative ranking of options. This process, described fully in Chapter 8, leads to multiple ranked lists which are in turn examined for commonality and differences (Hillestad and Davis, 1998). In future research on this topic, the actual preferences of policy makers could be identified by applying questionnaire-based methodology similar to that described in Thie et al. (2001).

6. THE ANALYTICAL MODEL AND RELEVANT MODELING ISSUES

This chapter documents the simulation model. It begins with a discussion of the model's basic stock-flow architecture, as well as its inputs and outputs. The second section instead focuses on the model's two most critical capabilities: tracking the YOS distribution over time and simulating promotions that take place through contests. The third and final section addresses issues of model validation, verification, and accreditation (VV&A). For ease of exposition, much of the detailed discussion is relegated to two appendices. Appendix D describes the structure of the model for each personnel category; Appendix E instead discusses specific techniques used to implement such a structure.

6.1 GENERAL APPROACH

The model is a time-stepped, stock-flow simulation built using the ITHINK modeling software. Given that the Italian Army's personnel system includes a series of complex interactions--with multiple flows into and out of a number of stocks--a simulation approach was deemed more suitable and feasible than closed-form analytic methods (Stokey and Zeckhauser, 1978; Miser and Quade, 1988). Simulations are also useful because they reproduce the system in what is the equivalent of a laboratory setting. Each "experiment" or simulation run spans 30 time periods, with each time period representing a year from 2001 to 2030. The values are reported at the end of each time period--that is, year *t* output summarizes the status of each stock on December 31, based on the flows that occurred from January 1 of the same year. As mentioned in Chapter 5, all strategies bring each personnel category (e.g., VSPs and Sergeants) to the official steady state size by 2020. Beyond 2020, inflows into each category are set to equal outflows in order to maintain the system in equilibrium.

Relatively early in the programming phase it became apparent that creating a single integrated model would not be practical. The size of ITHINK model files grew exponentially, especially with the introduction of arrays (see the next section). The computing power requirements of a

large model file proved to be prohibitive even for a top-of-the-line personal computer. To remedy the problem, the model was split in two--one sub-model covered the enlisted and Sergeant force, while the other focused on Marshals (refer to Appendix D for a fuller description of the specific features of each sub-model).[107]

This separation greatly eased model construction and the process of analyzing simulation results, without prejudicing the validity of the analysis. Indeed, Marshals can in many respects be considered as substantially separate from the other personnel categories under review. Most of its members are accessed laterally--flows from the VSP and Sergeant ranks account for less than a third of all new entries. And while all other categories need to increase their size to meet the steady-state requirement, Marshals instead have to undergo a process of downsizing. As a result, the number of total accessions is likely to remain small under all circumstances. Finally, given the distinct roles and skill sets assigned to Marshals as warrant officers, evaluating the outcomes for this category separately before integrating them with the results from the other categories (as explained in Chapter 7) adds a level of specificity to the analysis.

Building blocks (1): stocks

The smallest unit of analysis in the model is a year in grade (YIG)--each year spent in each grade is represented by one stock. If an individual needs to spend *n* years in a particular grade before becoming eligible for promotion, then that grade is represented with *n* stocks. Take the VSP2 grade, for instance--individuals in it are automatically promoted to VSP3 after 5 years. Assuming no other inflows or outflows, this grade could be represented as shown in Figure 6.1.[108]

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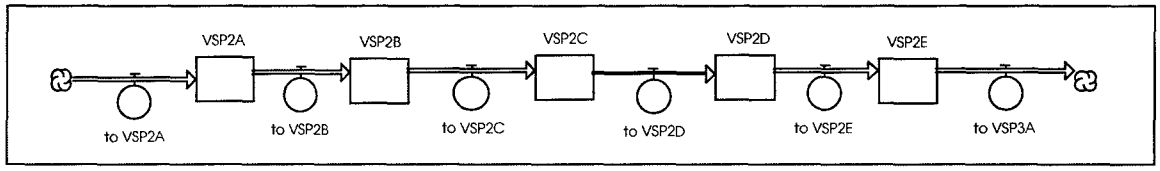
[107] As they stand, sub-model files occupy approximately 17 MB of disk space each.

[108] ITHINK enables the user to create multi-year stocks, called "conveyors". However, conveyors could not be used because they do not allow multiple and controlled outflows from each of their YIG elements.

Figure 6.1 Map of basic stock-flow structure for the VSP2 grade



Various YIG stocks in a grade are identified by a sequence of letters after the name of the grade; for grade *i*, the first YIG stock would be *i*A, the second *i*B, and so on. As a general rule, there are as many YIG stocks for a grade as the maximum number of years one can spend in the grade. The maximum number of years is specified by law for all grades, with the exception of the terminal grades (VSP4, S3, M3 and M4). For terminal grades, the total number of YIG stocks is obtained by calculating the maximum number of years before retirement a soldier could conceivably spend in the grade. For instance, if in theory one could become a VSP4 with 17 YOS, then the VSP4 grades would have 21 YIG stocks--enough to carry that individual to the latest retirement mark at the end of the thirty-seventh year of service.

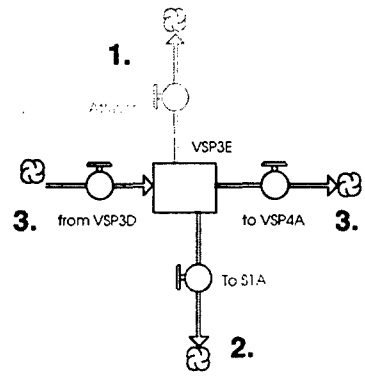
Building blocks (2): flows

The patterns of flows and the connections between stocks reflect the features of the personnel system as described in Chapter 3 (and portrayed in Appendix C). The model groups these flows in three separate categories, as follows:

- *Exits* (either through attrition or separation);
- *Promotion won by contest to another category (e.g., from VFB to VSP) or to the M4 grade;*
- *Promotion within the same category or advancement within the same grade (e.g., from VFB1 to VFB2).*

The timing of the flows is sequential: in a given time period, exit flows occur first, promotions to another category second, and progressions within the same category third (see Figure 6.2).

Figure 6.2 Timing of flows



This sequence was adopted to enable the proper calculation of flows from multiple YIG stocks into a single stock, a pattern that applies to promotions occurring through yearly contests (i.e., from one category to another and from the M3 to the M4 grade). ITHINK computes these promotions by performing several calculations in each time period, moving a fraction of the winners at a time. All attrition occurs in the first calculation prior to these promotion flows, while progression to other YIG stocks--whether in the same grade or in a different grade within the same category--takes place in the last calculation of each time period, once all promotions by contest are processed.

Individuals promoted by contest face a one-year delay before actually transitioning to their new post. This delay reflects the actual lead-time created by the current evaluation and assignment procedures. The model assumes that those who win a promotion contest wait for their transfer in the grade they had occupied when they began the promotion process.[109]

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[109] This is a simplifying assumption, since there could be some who took the exam the year prior to being promoted to a different grade (e.g. VSP2s with 4 years in the grade) and who do not obtain the promotion while they spend 1 year waiting. However, it is not a particularly bothersome simplification, since the numbers are relatively contained, the mismatch for each cohort does not last more than one time period, the impact on YOS/cost output is small, and the majority of the measures of effectiveness emphasize category-wide, not grade-specific, objectives.

Types of inputs and outputs

The information on the YOS distribution of personnel in each category and grade summarized in Chapter 4 constitutes the set of inputs used by the model at the beginning of the simulation. Data on future inflows and outflows was estimated using expert opinion and Army planning documents. As mentioned earlier, information on promotion timing and other rules was derived from official laws and regulations.

The major outputs of the model include data on the size of each stock at the end of each period.[110] As explained below, stock quantities are disaggregated by year of service. These raw results are then transferred to an Excel workbook, which rearranges them into easy-to-understand tables summarizing the YOS distribution for each grade and the associated costs.

6.2 SPECIFIC MODEL MECHANICS: TRACKING YOS AND PROMOTIONS THROUGH CONTESTS

Modeling personnel stocks and flows using ITHINK presents two interesting challenges. The first relates to the requirement of tracking the year of service distribution for each grade. The second has to do with the peculiar features of the Army's personnel system: as mentioned earlier, some promotions take place through contests to which personnel in different grades (and in different years in the same grade) can participate. Both are outlined below, and described in detail in Appendix E.

Keeping track of YOS

Individuals can enter into most grades at different times during their careers. For instance, some can become Marshals either with little or considerable experience, depending on whether they entered laterally as civilians or vertically as former VSPs and Sergeants. Some individuals may enter the Sergeants category either as young VSP2s or as much more senior VSP4s. To take these potential variations into account, the model represents each YIG stock as an array.

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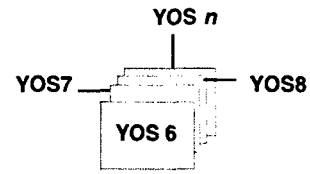
[110] The model also keeps track of the numbers of promotions to and exits from a number of grades each year.

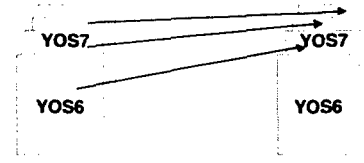
An arrayed stock contains more than one layer of information--it is essentially a combination of different elements that find themselves in the same location of the model at a particular time. In this analysis, the elements are individuals with different years of service; each YOS element contains information on the number of soldiers with the same YOS in the same YIG stock (see Figure 6.3).

Figure 6.3 Arrayed YIG Stock



When individuals advance through the ranks, they move from one element of an array to the next--such as from YOS6 to YOS7 (see Figure 6.4).

Figure 6.4 Transition between arrayed stocks



ITHINK does not allow for the automatic movement of information from one array element to the next; such movements have to be specified by equations that direct the flow in the appropriate way. These equations essentially create a transition matrix, which instructs the model to transfer a portion (ρ) of A's contents in array element *n* to array element *n+1* in stock "B." Multiple flows from a given stock are represented with multiple transition matrices.

Figure 6.5 Sample transition matrix

		To B			
		YOS6	YOS7	YOS8	YOS9
From A	YOS6	0	ρ	0	0
	YOS7	0	0	ρ	0
	YOS8	0	0	0	ρ

As mentioned in Appendix E, software limitations precluded the use of a single large array for all grades. In fact, in most cases an individual array was created for each grade. The flows from one array to another follow the same logic laid out for intra-array movement, that is, a transition matrix specifying the flows from one element of one array to another element of a different array is created for each possible connection (see Figure 6.6).

Figure 6.6 Cross-Array Transition Matrix

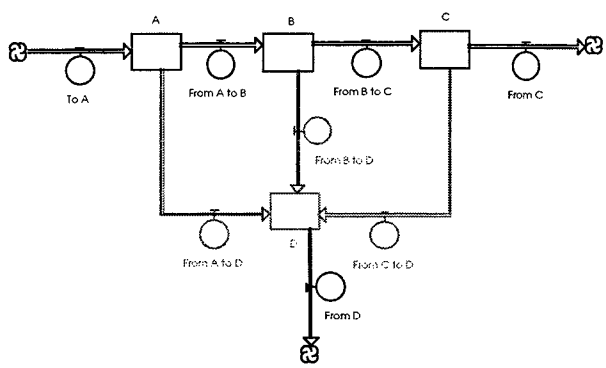
VSP2 Array

VSP1 Array	8	9	10	11	12	13	14	15	16
7	ρ	0	0	0	0	0	0	0	0
8	0	ρ	0	0	0	0	0	0	0
9	0	0	ρ	0	0	0	0	0	0
10	0	0	0	ρ	0	0	0	0	0
11	0	0	0	0	ρ	0	0	0	0

Promotions through contests: handling multiple flows

The presence of contest-related promotions implies that there could be multiple flows into particular stocks--for instance, individuals from three different VSP grades (and with different years in those grades) can in principle be promoted to S1. The basic properties of this mechanism are portrayed in Figure 6.7.

Figure 6.7 Multiple flows into stock D



Assume for simplicity that A, B, and C are all YIG stocks for the same grade. At every time period, a given number of individuals from

these stocks flows to D, while the remainder progresses in sequence (from A to B, B to C, and C to exit). Army regulations impose an overall quota on the combined flows to D from A, B, and C, but do not differentiate how those flows should be divided among the YIG stocks.

To simulate this process most efficiently, the model was instructed to give A, B, and C the *opportunity* to contribute uniformly to D. This is different from specifying a priori that all stocks contribute a fixed and identical share, given that there is no guarantee that all would be "full" enough to equally contribute at all times during the simulation.[111] The techniques that were adopted enable the model to dynamically adapt flows to D as a function of the relative quantities of stocks A, B, and C (for a detailed explanation of this process, refer to Appendix E).

6.3 VALIDATION, VERIFICATION, AND ACCREDITATION ISSUES

The discussion of the way the Army's personnel system is modeled--as well as of the assumptions that were made in the process, brings to the fore a series of questions on the topic of validation, verification and accreditation. How well the model represents the system it simulates, and which steps were taken to ensure that it faithfully represents its basic concepts in an acceptable way (Greenberger, Crenson, and Crissery, 1976), is a critical issue that ultimately determines the quality and the relevance of the simulation and its results.

Model validation

Validation is "the process by which analysts and other users judge the extent to which outputs obtained from a model represent the behavior of the selected aspects of the phenomena being modeled, and thus estimate the degree of confidence that should be placed in the model" (Miser and Quade, 1988, p.534). In the strictest sense, the model

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[111] Fixed rules regulating multiple inflows could only be implemented if one had the certainty that in each YIG stock could supply its share of D's demand at every time period. This is a very unlikely prospect, especially since the system is in a transitory state for much of the simulation, and several of the YIG stocks begin and remain empty for considerable lengths of time.

discussed above is not validated--that is, it cannot precisely predict the YOS distribution of the force in the future in the same way a scientific theory can predict the properties of a well-known physical system (Hodges and Dewar, 1992). *This does not mean that the model is not valid and therefore useless, however.* In fact, most experienced modelers have argued that models can be valid in several distinct ways (Davis, 1992), and that validity depends in large part on the nature of the problem and objectives of the analysis.[112]

The model described here is valid as a tool that predicts with some uncertainty--that is, it produces estimates of how the system will behave over time for a *given set* assumptions about parameters. It also plays a large descriptive role, since one of its principal aims is to test system behavior and the system's responses to various policies (see section 5.2 for a discussion of the model's objectives and boundary). The choice of adopting a deterministic approach to modeling is in line with this basic rationale--model results vary according to the choice of policy parameters and decision rules, but such changes are not defined stochastically. The introduction of stochastic elements was not deemed to be particularly useful, since it would have created another layer of complexity to a model that can meet its objectives without greater predictive power. Moreover, as mentioned in Chapter 5, the basic lack of information on a large set of policy parameters and individual

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[112] On this point, Miser and Quade state that "[t]he variety of issues that are considered in validating models for systems analysis makes this process differ from one that might be used to test whether or not a new model represents progress in developing scientific theories, where a model that is shown to be a closer fit to the phenomena is considered to be an improvement. The systems analyst, on the other hand, balanced goodness of fit with the uses to which the model and his/her findings will be put, and with the complications the model will introduce into the analysis. For example, he/she prefers a simple model, even though it is quite approximate, unless a more complex model can be shown to improve the findings enough to make the additional computational complexity worth its costs in time and money" (Miser and Quade, 1988, p.536). Moreover, several scholars have argued that demands for truly "valid" models are impossible to satisfy given that they are by definition simplifications of real-world phenomena (Forrester, 1961; cited in Sterman, 2000).

behavior would have made it difficult for the model to acquire significantly increased predictive power through a stochastic approach.

Thus, the model is not able and does not attempt to predict with 95% confidence the YOS distribution in year t. But the model can be used to reason about how potential changes made in the future could affect the system and to suggest policy changes that can improve the performance of the system (Dewar et al., 2000). In this context, therefore, the steps for ensuring validity primarily focused on the expert opinion of a number of Italian Army planners and of the dissertation committee, who (1) helped determine which factors to include, (2) whether model assumptions mentioned above and in Chapter 7 are justifiable, (3) whether the factual foundations of the work are credible, and (4) whether variable interaction is "reasonable" (Miser and Quade, 1988).

To be sure, the model could acquire greater predictive power--and validity--over time, as some of elements assumed away in Chapter 5 become better known and easier to model with a higher degree of confidence. Some of the feedback effects that are at this stage unknowable--such as changes in individual behavior resulting from slow promotion tempo--will be observable during the course of the transition, and the simulation could be adjusted to reflect them (perhaps even probabilistically). The ITHINK architecture does indeed make it relatively easy for model users to alter the relationships between stocks and flows to include such feedback effects.

Model verification

For the purposes of this analysis a series of verification tests were employed, following Gass (1983, p. 609).[113] These tests can be categorized as either experiments aiming to remove bugs in the programs' logic, or as checks on the ways in which the simulation program computes and processes numerical data. Experiments included following the progress of a single cohort through the various paths that the system's structure makes possible during the course of one's career: are individuals progressing correctly? Are the array elements being updated

[113] First cited in Miser and Quade (1988).

as personnel flows from stock to stock? Others instead focused on the promotion contests (e.g., VSP to Sergeant) to verify that the size and timing of contributions from separate YIG stocks flowed as specified by the yearly quota. Array sum calculations for each stock were performed to ensure that there was no leakage in the system, other than that prescribed by the various exit flows. These tests, which were performed throughout the entire process of model construction, verified that the model can accurately "keep the books."

Model Accreditation

Model accreditation is "a one-time, ad hoc decision based on informed judgment about a model's suitability, applicability, and acceptability for a particular decision or analytical purpose" (Sanders, 1997, p.350). Essentially, a model can be accredited when it is found to be adequate for the task at hand. Accreditation certifies that the steps taken to ensure validity and verification are sufficient "to justify using a model in a particular application" (Davis, 1992, p.13).

Several factors ensure that the model created for this dissertation can be considered as accredited. First, personnel stock-flow simulations of large organizations such as the Army have been widely used to understand the fundamental dynamics at work, as well as which corrective policies could be implemented to improve outcomes (Sterman, 2000). Second, the systems approach methodology--and the class of software packages to which the one used here belongs--have been adopted by others to model military personnel management problems, especially since the advent of affordable and powerful personal computers (Rostker, 1997). Third, the range of "safe" uses for the model is clearly demarcated by an explicit discussion of (1) its objectives and the types of conclusions that can be confidently drawn from it, (2) the limitations inherent in the methodology, and (3) the limitations resulting from the use of simplifying assumptions (Davis, 1992). Finally, the dissertation committee intervened as a de facto accrediting body, relying on years of modeling expertise to judge the acceptability of the modeling approach.

7. PRIMING THE MODEL AND RESULTS FROM THE BASE CASE

This chapter begins the exploration of the results from the model-based policy analysis by illustrating the simulation's base case and the outcomes it produces. Its first section provides the necessary background information on the policy levers and their default values. Running the model on these default settings produced a baseline scenario, which presents a "best guess" of how the system should evolve over time, *ceteris paribus*. The results from the base case are summarized in the second and final section.

7.1 THE POLICY LEVERS AND THEIR DEFAULT VALUES

The ITHINK model described in Chapter 6 allows the user to manipulate a number of policy-relevant variables. These, along with their default values, are summarized below for each personnel category.

Junior enlisted policy levers

The variables used to regulate the flows of personnel in the junior enlisted ranks--VFAs, VFBs, and those renewing their VFB term--are summarized in table 7.1 below. As explained in Chapter 5's discussion of model boundary, hiring quantities are treated as exogenous--their values do not depend on other variables modeled in the system. For VFBs, the long-term value represents the steady-state intake of 6,000 per year; the intakes for the first two years of the simulation instead reflect the Army's current recruiting targets. VFA flows are constant at 14,000 until conscription is finally phased out in 2007, drop by more than half from 2007 to 2010, and then fall to zero for the remainder of the simulation. Again, this pattern approximates the expectations of Army planners.

Table 7.1 Junior enlisted policy levers and default values

Policy lever	Default value
VFA hires	14k from 2001 to 2006; 6k from 2007 to 2010; 0 thereafter
VFB hires	7.3k in 2001; 7.8k in 2002, 6k from 2003 onward
VFA to VFB promotion rate	10%
To police force	33%
To VSP	30%
To Renew	25%
To civilian life	75%
Attrition	1%

The other variables in Table 7.1 regulate the flow of personnel at critical career junctures. For instance, at the end of the first term a third of all eligible VFBs transfer to police services; the remainder instead competes for a position in the VSP force. Out of those who fail to be promoted, 25% choose (or are allowed) to renew, while the remainder permanently exits the force. Such values either incorporate formal guidance from government law or Army regulations, or expert opinion. Attrition is assumed to be constant at 1% per annum for each YIG stock, in line with Army planning factors.

VSP/Sergeant policy levers

As shown in Table 7.2, all the relevant VSP and Sergeant policy levers regulate the size of inflows to and from these categories.

Table 7.2 VSP and Sergeant policy levers and default values

Policy lever	Default value
Yearly promotion quota to S	1.7% of the sum of all VSP2/3/4s
Share of VPS2 and VSP3	30%
Share of VSP4	70%
Yearly quota to M	150 until 2020; 200 thereafter
Share of VSP	70%
Share of S	30%
Attrition: VSP and S	1%
Retirement probability: VSP and S	25% @ 35 YOS; 50% @ 36; 100% @ 37

The yearly promotion quota to the Sergeant category is expressed as a percentage of the size of the eligible pool of soldiers. This is in line with the Army's preference for promotion tempo to be fairly constant over time, and for the Sergeant stock to reach its steady-state values relatively gradually.

The number of slots available for promotion to the Marshals category is originally defined in the Marshals sub-model. The yearly quota is fixed and known up to 2020; once the steady-state is reached, the demand for vertical entrants depends on total outflows from the Marshals category.[114] Since the two sub-models are not connected in real time, the number of available Marshals slots in VFA to Sergeant sub-model for the 2021 to 2030 period is also assumed to be constant. Its value equals the average number of vertical hires recorded in the Marshals sub-model during the same time frame (as indicated in Table 7.2, the default value is of 200 promotions per year).[115]

The retirement probabilities shown in Table 2 applies to the entire VSP and Sergeant force--they are expressed in terms of *actual* years of service (the administrative YOS count is typically greater by three years). It is intended to be a fair approximation of the retirement probabilities currently seen in the Marshals category--the only career-force under review for which historical retirement rates are available. The timing of retirement is pushed back three years compared to today's patterns to account for the eventual raise in the minimum retirement age, which will most likely lead to a maximum career length of 37 YOS, instead of the current 34.[116]

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[114] For each strategy the Marshals sub-model is run first in order to obtain an estimate of this category's demand of vertical entrants. These parameters are subsequently fed into the VFA to Sergeants sub-model.

[115] To be sure, this is an approximation; however, it is made more defensible by the fact that none of the strategies considered in this document led to wild swings in the yearly demand of vertical entrants after the steady-state is achieved.

[116] See Chapter 3.

Marshal policy levers

As mentioned above, Marshal intakes are fixed until the system reaches the steady-state in 2020; this value was taken from draft Army planning documents. Table 7.3 indicates that there should be 350 lateral entries each year up to the attainment of the steady-state; from thereon, inflows will match the previous year's outflows. The default values determining the size and source of flows into M4 also reflect current rules and policies.

Table 7.3 Marshal policy levers and default values

Policy lever	Default value
Yearly demand for new hires up to 2020	500 up to 2020; yearly outflows thereafter
Lateral entry share	70%
Vertical entry share	30%
Yearly promotion quota to M4	Yearly outflows from M4
Share of M3 (1 to 7 YIG)	30%
Share of M3 (8 YIG)	70%
Attrition	1%
Retirement probability	From 2001 to 2005 25% @ 32; 50% @ 33; 100% @ 34 From 2006 onwards 25% @ 35; 50% @ 36; 100% @ 37

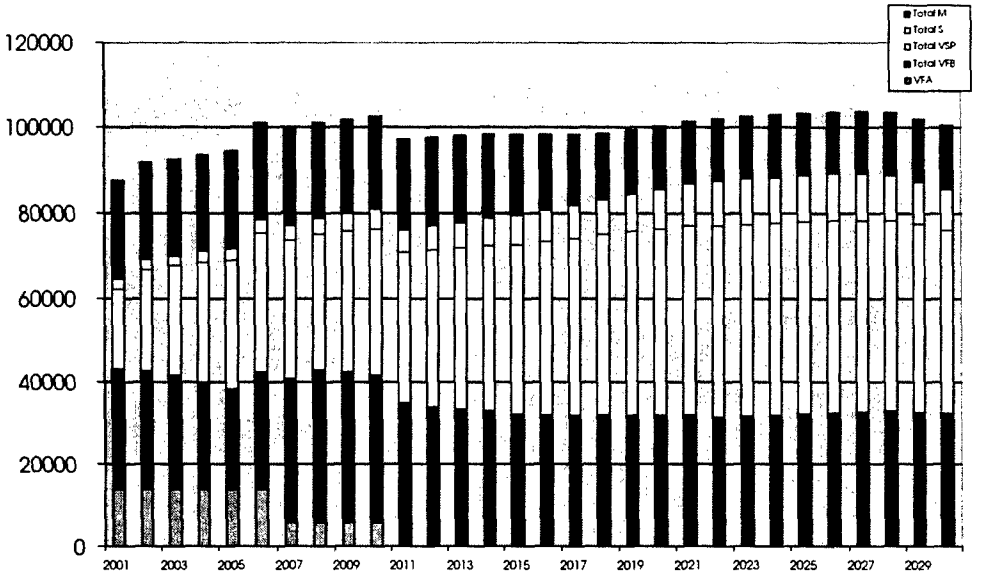
Unlike the VSP or Sergeant categories, the Marshals force begins the simulation with a substantial number of senior personnel; this implies that retirements will take place before the regulations lengthening military careers take full effect in 2008. The retirement probability parameter takes this into account by keeping the 34 (actual) YOS ceiling until 2005 (along with the retirement probabilities for the two years prior to the limit), and then raising it to 37 for the remainder of the simulation.[117]

[117] This is an approximation of the more gradual increase in the age limits shown in Table 3.3. Having said that, test runs have demonstrated that the results do not significantly vary from the ones that would be obtained with a more detailed but more complicated treatment.

7.2 RESULTS FROM THE BASE CASE

The parameter values described in section 7.1 were used to obtain results for what is termed the "base case"--also called strategy 1. In the base case, the Army successfully reaches its 2020 targets for each personnel category, as shown in Figure 7.1.

Figure 7.1 Base Case (Strategy 1): Overall size by category



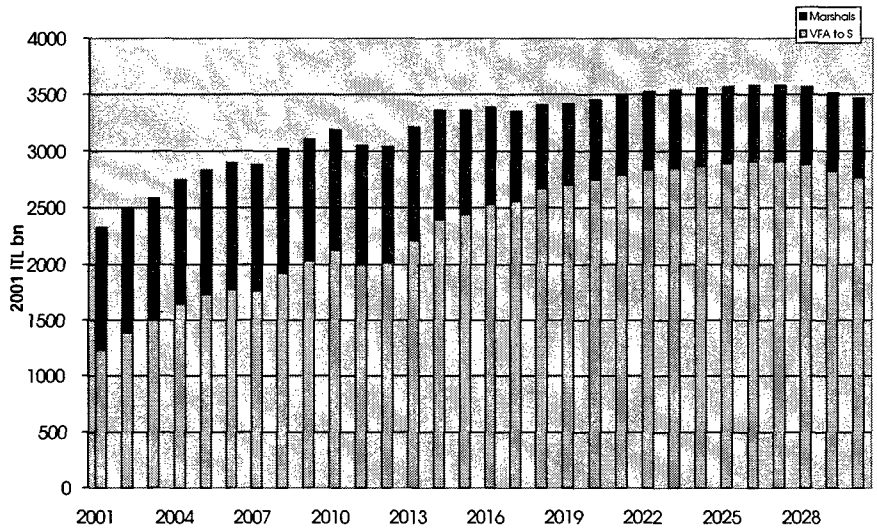
The surge in quantity during the 2006-2010 time period is linked to an increase in the VFB stock, which is in turn caused by the lengthening of the junior enlisted term from 3 to 5 years. The dip in 2011 is associated with the sudden termination of VFA recruitment. From 2011 onward, the system remains close to 100,000 soldiers, but the category mix changes over time. The slight excess of total personnel from 2020 onward is determined by the system's inability to adjust instantaneously to changes in outflows. These lags cause the model to marginally under- and over-shoot personnel intakes as a result.[118]

Figure 7.2 summarizes the active-duty personnel costs associated with every year of the simulation in 2001 bn Liras. The chart indicates that total costs steadily rise up to 2020 and then stabilize once the steady state is reached. It also shows how the Marshal category's share of costs is reduced over time--both as a result of the absolute decrease

[118] The delay is realistic, and is in part determined by the additional year contest winners wait before securing their promotion.

in the quantity of Marshals, and of the increase in the stocks of other career personnel (VSPs and Sergeants). The small dip in costs around 2011 reflects a similar decrease in force size, as explained above.

Figure 7.2 Active-duty personnel costs (base case)



By examining the changes in the size and composition of the VFB category one can note that the stock of junior enlisted personnel reaches its steady-state values relatively early (and painlessly) in the simulation. The size of first-term VFBs very closely approximates 30,000 from 2012 onward, and renewals remain contained until the last periods of the simulation (see Figure 7.3 below).

Figure 7.3 Junior enlisted composition (VFAs, VFBs, Renewals)[119]

The data on the career force categories does not point to a similar balance, however. For the base case, model output clearly shows that the force will have large and persistent concentrations of personnel in a small number of YOS. Figures 7.4 to 7.6 on the next page display the YOS distribution for VSPs, Sergeants and Marshals in different years of the simulation. As they indicate, the "hump" currently afflicting the Marshals category will remain until the late 2010s, while its counterparts in the VSP and Sergeant categories are expected to persist for more than three decades.

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[119] Figure 7.3 does not include those waiting promotion into VSP1 (in the Pre-VSP1 stock). Pre-VSP1 quantities are actually included in the as part of the total VFB stock for accounting purposes, however.

Figure 7.4 VSP YOS Distribution (base case)

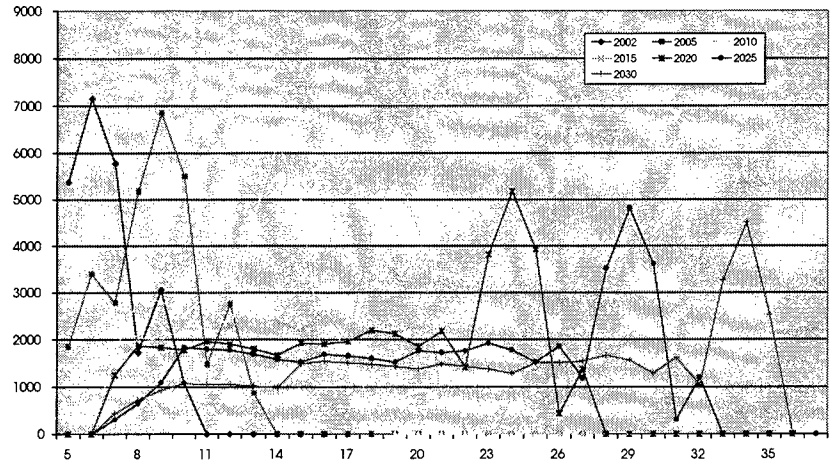


Figure 7.5 Sergeant YOS Distribution (base case)

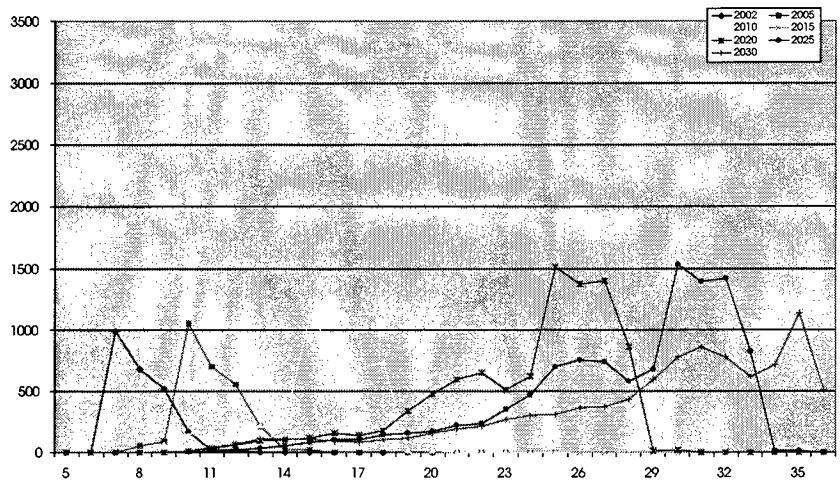
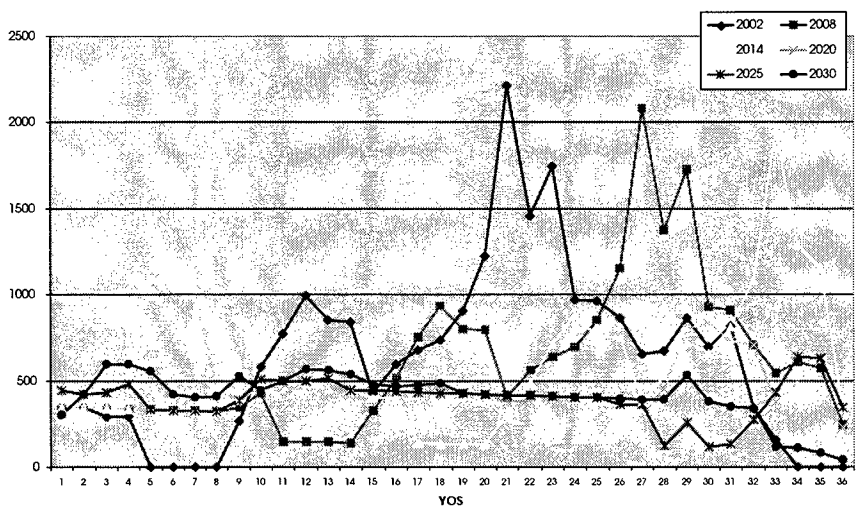


Figure 7.6 Marshal YOS Distribution (base case)



As explained in previous chapters, these spikes, coupled with long career lengths, could have a series of negative repercussions on personnel management and even total effectiveness as long as they exist. In addition, and given their persistent nature, they will also lead to a very senior Marshal force in the medium term, and an very senior VSP and Sergeant force from 2020 to 2030 (see Figures 7.7 to 7.9 on the next page).

Figure 7.7 VSP YOS mix by age group (base case)

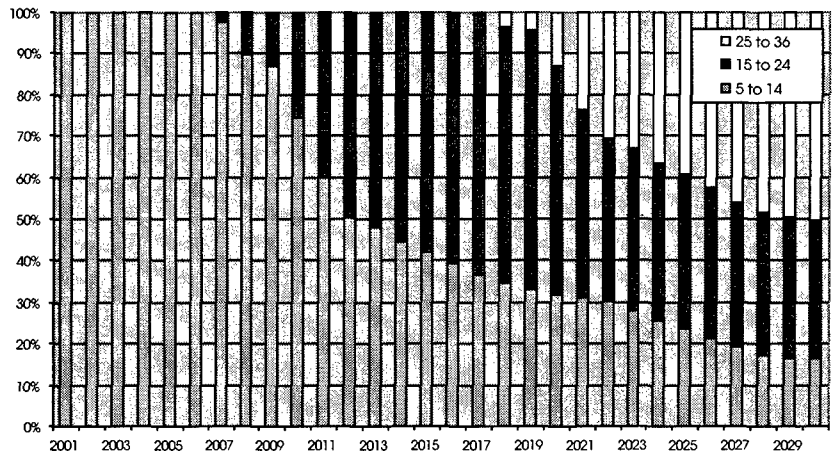


Figure 7.8 Sergeant YOS mix by age group (base case)

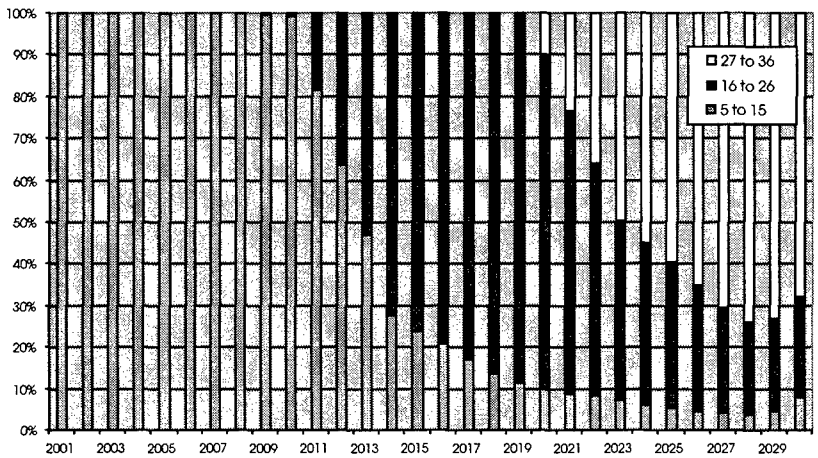
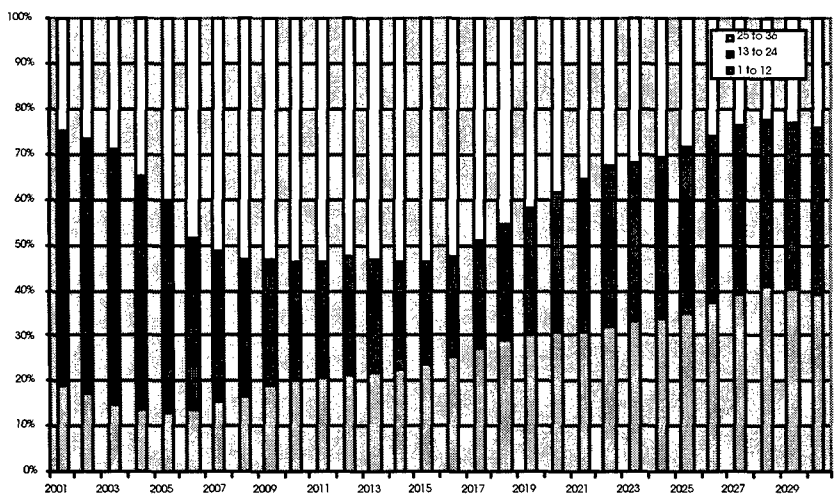


Figure 7.9 Marshal YOS mix by age group (base case)



The results from the base case also point to a related and equally undesirable phenomenon: large quantities of soldiers in the terminal grade. As shown in Figure 7.10 on the next page, the problem for VSPs progressively worsens after the steady-state is reached and persists until the end of the simulation. Figure 7.12 instead shows that the two terminal Marshals grades (M3 and M4) make up a disproportionate share of the category well into the 2010s. The S3 grade (shown in Figure 7.11) does not reach similarly high shares of its category, in large part because of the considerable numbers of years one must spend in service before reaching this terminal grade. The fact that the simulation also begins with some relatively senior Sergeants increases personnel turnover in the final years of the simulation, as these individuals retire from service before their counterparts in the "hump".[120]

[120] Having said that, the next Chapter will show how even the actual share of S3 from 2020 onward exceeds Army planners' goals.

Figure 7.10 VSP grade share (base case)

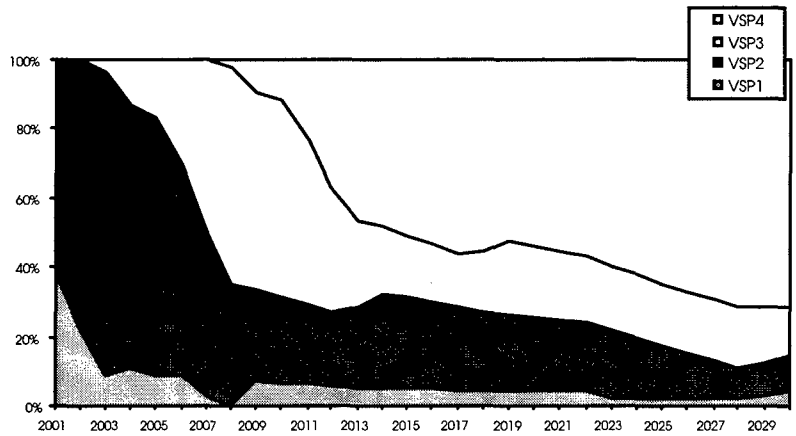


Figure 7.11 Sergeant grade share (base case)

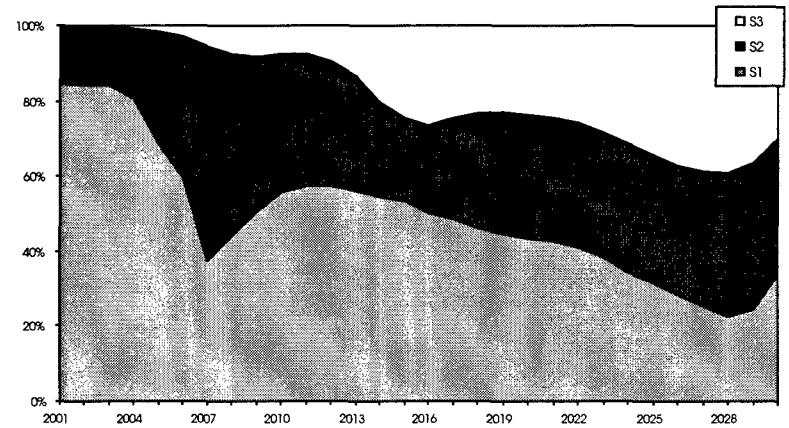
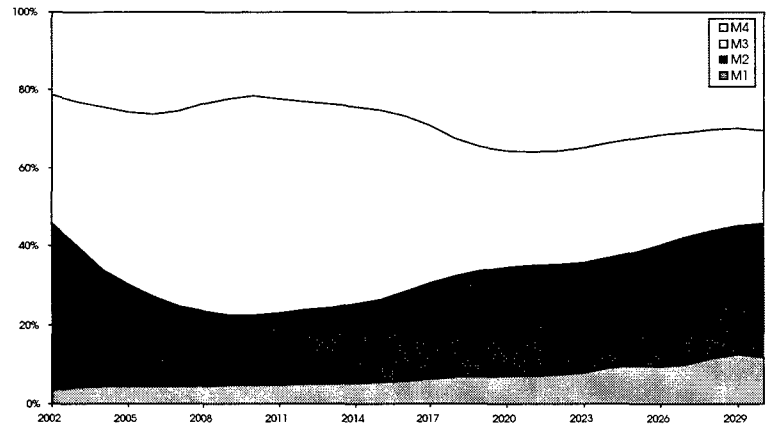


Figure 7.12 Marshal grade share (base case)



The disproportionate shares of individuals in the VSP and Sergeant terminal grades are exacerbated by the marked deterioration of promotion opportunities into these categories after the steady-state is reached. This is directly linked to the fact that by 2020 VSP and Sergeant stocks reach capacity and no significant outflows--and therefore inflows--take place. Marshals experience a similar problem but earlier on in the simulation--few M4 exits slow down promotions from M3 in the short-to-medium run. These exits increase in the medium run but then decrease again in the long run, causing swings in promotion possibilities. These points are illustrated in Figures 7.13 to 7.15 on the following page. The dip in VFB to VSP promotions occurring in the early stages of the simulation (shown in Figure 7.13) is caused by the switch from a three-year to a five-year term for VFBs.[121]

[121] The transition obviously takes two years--in the first year, inflows to VSP are entirely made up of individuals who were renewing their term. Once the renewal stocks are emptied, no promotions can take place in the following year.

Figure 7.13 VFB promotions to VSP as a % of eligible (base case)

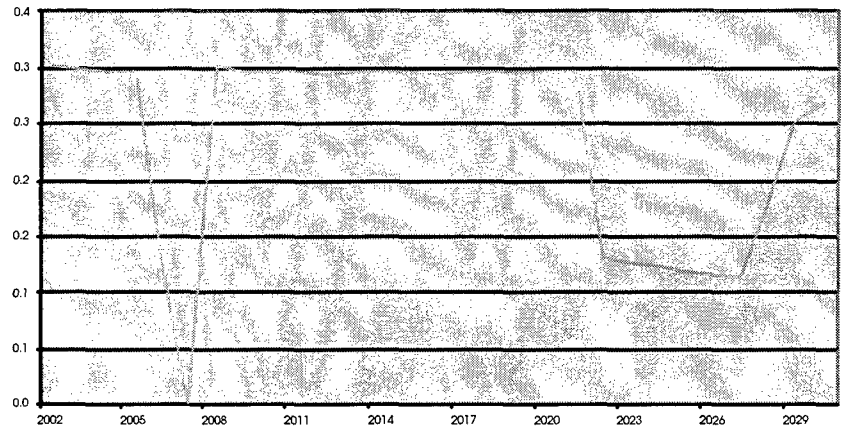


Figure 7.14 VSP promotions to M and S as a % of eligible (base case)

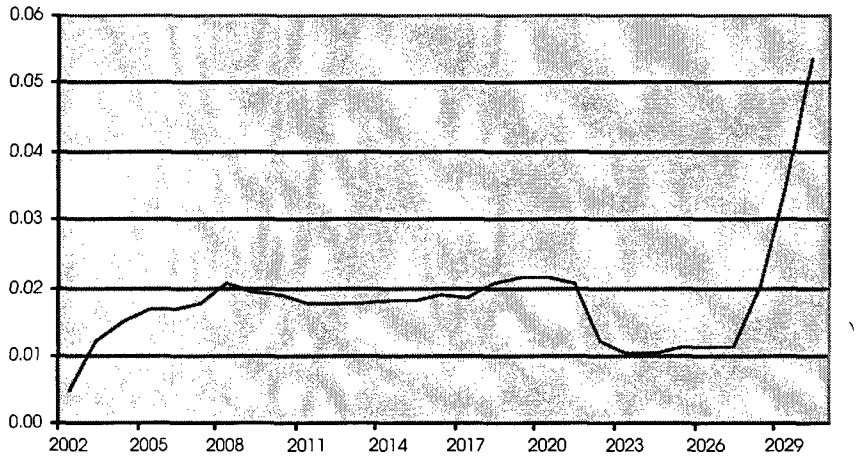
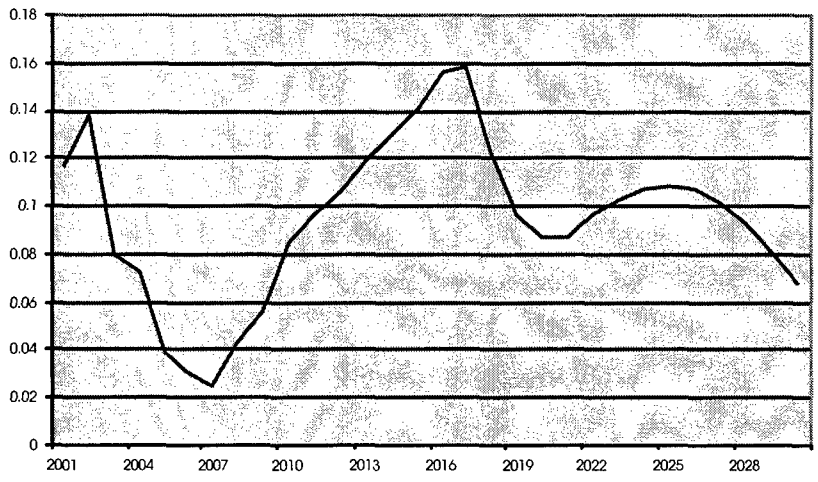


Figure 7.15 M4 promotions as a % of M3 (base case)



These results confirm the problems first highlighted in Chapters 3 and 4: a number of imbalances prevent the system from reaching a stable equilibrium over time. Moreover, these imbalances are amplified by traditionally low attrition rates and the considerable length of military careers. To further underscore the system's structural inflexibility, an "early steady state" scenario was constructed to verify the consequences of a strategy that seeks to reach the steady-state mix in 2010. As charts 7.16 to 7.18 indicate, the outcomes for the VSP and Sergeant force would be disastrous: greater age imbalances, more individuals in terminal grades, and virtually no promotions for almost two decades.

Figure 7.16 VSP grade share (early steady state scenario)

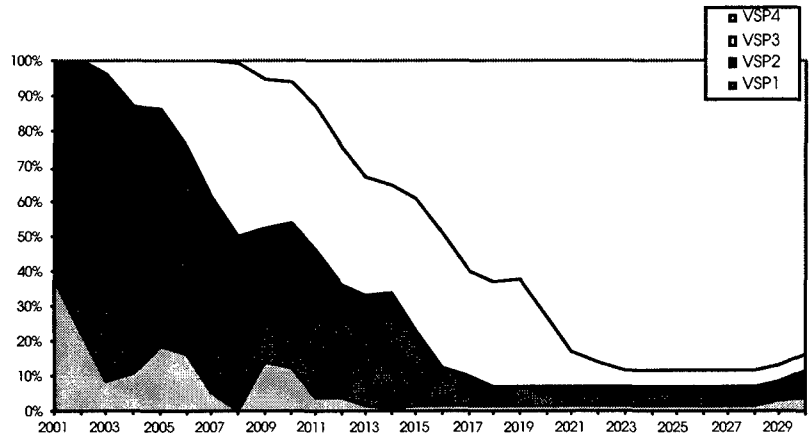


Figure 7.17 VSP YOS mix by age group (early steady state scenario)

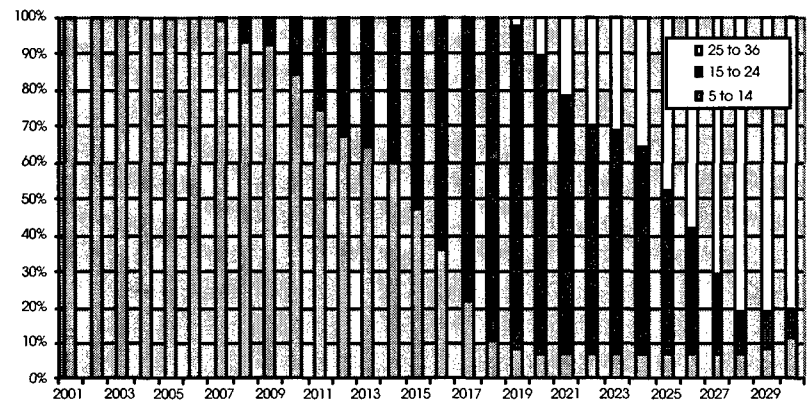
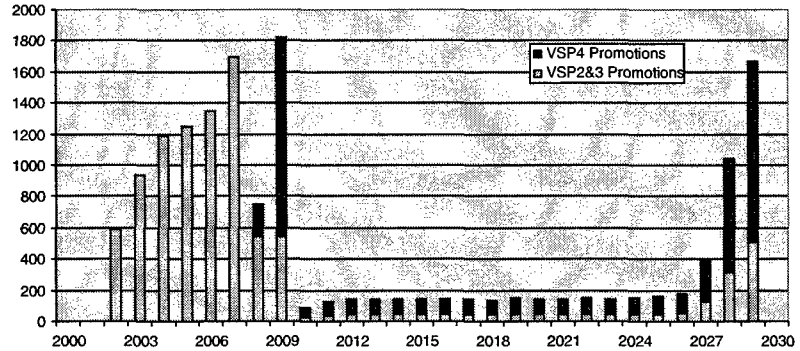


Figure 7.18 Promotions from S1 from VSP2, 3, and 4 (early steady state scenario)



8. IDENTIFYING AND COMPARING ALTERNATIVE STRATEGIES

The unfavorable outcomes of the base case scenario underscore the need to perform a search for alternative transition paths and policy interventions. This chapter describes how strategies designed to improve system performance were identified and how their results were evaluated and compared. The first section introduces four additional strategies that prescribe alternative transitions to the Army-specified steady-state mix. The second sets the stage for the policy analysis by specifying target values for each of the measures of effectiveness described in Chapter 5. With this information in hand, the remainder of the chapter focuses on evaluating, comparing and ranking the different options.

8.1 IDENTIFYING ALTERNATIVE STRATEGIES

As first described in Chapter 5, the search for alternatives was conducted in two stages. In the first phase of the search process each policy lever was parametrically altered multiple times in order to verify the impact of such changes on model outcomes. The hundreds of runs required in the first phase were performed using ITHINK's sensitivity analysis capability, which allows the program to compute a large number of iterations with different parameter specifications. The results from these were then automatically transferred via an Excel macro to a spreadsheet file which then reorganized the data into easy-to-comprehend summary charts and tables (see Appendix F for a copy of the macro employed).

In the second stage those policy variables with the greatest degree of leverage were combined to construct full-fledged strategies. The combinations simultaneously vary several parameters, as well as the timing of such variations during the simulation. A large number of alternatives were explored; four shown in Table 8.1 appeared most interesting.

Table 8.1 The four alternative strategies

Strategy #[122]	Description
2	Aggressive early separation (ES)
3	Gradual ES
4	Gradual ES with VSP promotion facilitation
5	Gradual ES with early "hump" reduction effort

It is no coincidence that all strategies contain a prominent early separation/early retirement element. Early separation quickly emerged as the policy instrument with the greatest amount of leverage. The effects of other variables were therefore explored in conjunction with, and not as substitutes for, early separation programs. The four strategies are briefly described below; Appendix G provides a summary of how the policy levers were altered for each.

The major difference between the base case and **Strategy 2** is the timing of retirement. The first retirements occur after twenty-nine years of service, 6 years ahead of the default value.[123] This in practice means that the maximum career length is shortened from 37 to 31 years after a five-year "grace period."[124] Since this separation rule increases early exits, promotions to the Marshals category (both lateral and vertical) are commensurately higher.

Strategy 3 instead offers a more gradual way of retiring personnel early: for the Marshals category early separation does not kick in until 2006; from thereon, 10% of each cohort between 28 and 34 YOS leaves every year (this applies to the VSP and Sergeant force as well). The

[122] The base case is considered as "Strategy 1."

[123] The pattern of retirement probability is the same as that of the base case: 25% of the class retire with 29 YOS; 50% of those remaining beyond this point retire with 30 YOS, and the rest leaves with 31 YOS.

[124] Such a grace period applies to all strategies and is only relevant for the Marshals category, since Marshals form the only group of soldiers old enough to retire in the first stages of the simulation. The basic effect of the grace period is to delay early separations until the mid-2000s, in order to offset the statutory increase in the retirement age that will take place at that point.

retirement patterns for YOS 35 to 37 are the same as in the base case (25%, 50%, 100%). Again, early separations have the effect of increasing the intakes of Marshals, and therefore of promotions from the VSP and Sergeant categories.

Strategy 4 is similar to 3 in the way it manages early separations, but differs markedly on the promotion front. In fact, Strategy 4 attempts to reduce the abnormal spikes in the VSP force by aggressively promoting these personnel into the Marshals category early on in the transition. To do so, it significantly increases the intake up to 2011 (drawing exclusively from VSPs, not Sergeants); maintains levels comparable to the other strategies up to 2020, and increases the long-term share of vertical entrants from 30% to 50%.

Finally, **Strategy 5** provides a more direct way of reducing the "hump" in the career enlisted ranks: it separates individuals in the initial stages of their careers. Early separations targeting young cohorts are managed in the 2003 to 2011 period, during which 10% of VSPs between 8 and 10 YOS exit prematurely. This strategy also institutes an early separation program for more senior soldiers similar to the one described for Strategy 3. The other significant change made by this strategy is that 10% instead of 30% of the M4 slots are made available to those M3s who have served less than 8 years in the grade. This change was implemented to increase the average age of M4s, and therefore to reduce the share this terminal grade has over the course of the simulation.

8.2 ESTABLISHING THE METERS FOR COMPARISON: TARGET VALUES

As mentioned in Chapter 5, the outcomes associated with these strategies have to be compared on a set of measures of effectiveness. Each measure of effectiveness carries a target value, and deviations from this are in turn used to evaluate each strategy's performance over time. This section briefly summarizes the target values used.

Measures of effectiveness and their target values

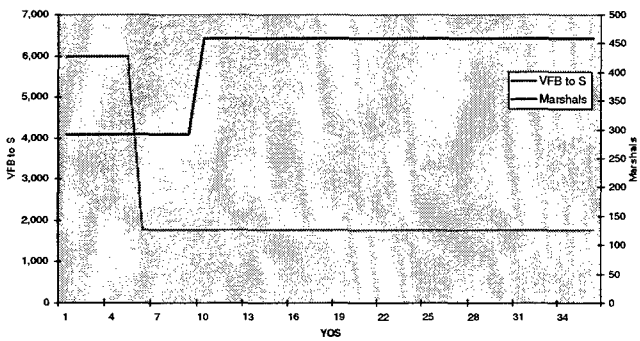
The values described below were used as benchmarks; they are "ideal" in the sense that they represent expert opinion of what would constitute a desirable outcome. Importantly, they may or may not be

easy targets to reach given the systems' current features.[125] What follows reflects the latest Army guidance as well as the views of Army experts, and does not constitute a set of absolute truths. To address the inherent softness of some of these parameters, sensitivity analysis was undertaken to verify how the relative performance of each strategy would be affected by changes in target values (see section 8.8).[126]

Averaged squared deviations

Performance on this measure is gauged with two "flat" YOS profiles--one for the VFB to Sergeant categories, the other for Marshals (see Figure 8.1). The score assigned to each strategy is relative to zero, which represents the target squared deviation. As mentioned in Chapter 5, implicit in these profiles is the simplifying assumption that individuals are distributed uniformly--for instance, 30,000 VFBs would be distributed evenly with 6,000 individuals in each of the 5 YOS slots.

Figure 8.1 VFB to S and Marshals ideal YOS profiles



Deviations are measured for every time period in the simulation, but performance is recorded in four representative years: 2010, 2015, 2020, and 2030 for VFBs to Sergeants, and 2010, 2015, 2020, and 2030 for

[125] Indeed, one could reach important policy conclusions about the structural properties of the system (and the objectives that drive it) in the case no reasonable strategy could come close to meeting such target.

[126] Moreover, the analytical process reported in this chapter can easily be updated to incorporate a different set of standards if one wished to do so. Systematically gauging the preference of several decision makers was not a primary goal of this dissertation. Future efforts on this front could benefit from the methodology developed in Thie et al, 2001.

Marshals.[127] The unequal time frames adopted reflect the fact that different sectors of the system reach critical points at varying stages of the simulation. By giving more emphasis to particularly relevant time periods for each sub-model, the analysis can benefit from a greater level of detail where it is most useful.

Career force distribution by age group

The size and YOS range of young and old age categories differs between Marshals and VSPs/Sergeants. In the case of the former, the "young" age group comprises individuals between 1 and 11 YOS, while the "old" group includes those with 24 to 36 YOS. For VSPs and Sergeants young individuals range from 7 to 16 YOS, while personnel in the older age group is between the 27th and 36th year of service.[128]

The target shares for these age groups are not identical to those that would be derived by using the steady-state YOS profiles shown in Figure 8.1, which are only meant to roughly measures the "spikeness" of a YOS distribution.[129] The figures reported in Table 8.2 were determined with the help of Army planners during a number of data-gathering meetings and exchanges.

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[127] These years are representative in the sense that they provide results similar to those that would have been obtained if adjacent time periods had been selected.

[128] The Pre-VSP year--the sixth year of service for most individuals --was not counted when constructing this range. In fact, Pre-VSPs are considered VFBs until they formally enter the VSP1 grade.

[129] The stylized profiles shown in Figure 8.1 do not necessarily reflect the Army's expectations of what should be the distribution of personnel by age group, especially if one takes into account the fact that (1) individuals can be promoted to other categories (e.g., Marshals), and (2) personnel at every YOS leaves as a result of attrition. However, they are quite adequate for measuring "humps," and do so far more parsimoniously than any more specific YOS profile that approximates more closely the percentage shares by age group reported in Table 8.2 (see next page).

Table 8.2 Targets for age group shares

Category/Age group	Target share
VSP & Sergeants	
Young (7 to 16 YOS)	40%
Old (27 to 36 YOS)	25%
Marshals	
Young (1 to 11 YOS)	33%
Old (24 to 36 YOS)	33%

As with all the targets that follow, performance for the non-Marshal categories was measured by averaging outcomes over four time intervals: 2001 to 2010, 2011 to 2020, 2021 to 2025, 2026 to 2030. Since currently there are no senior soldiers in the VSP and Sergeant categories, performance up to 2020 for these categories is not given weight.[130] Performance for Marshals for this and other targets was instead measured in averages from 2001 to 2010, 2011 to 2015, 2016 to 2020, and 2021 to 2030.

Terminal grade share

The advice of Army planners was also used to define the ideal shares for terminal grades. The target for VSP4s is **40%**; the one for S3s is **20%**. For Marshals, the M3 quota is of **35%**, while the M4 grade is of **20%**. Since the VPS4 and S3 stock begin the simulation without personnel, outcomes for these two measures of effectiveness are considered from 2010 onward.

Promotion opportunities

The following table summarizes target promotion rates; these are in part derived by canvassing Army expert opinion and internal planning and policy papers, and in part from informed estimates made by the author based on indirect Army guidance.

Table 8.3 Target promotion percentages

Promotion rate	Target

[130] All strategies perform equally poorly on this measure in the early stages of the simulation, implying there is little additional insight gained from including this data.

From VFB to VSP	30%
From VSP to M and S	3%
From M3 to M4	15%

Distance to steady state

In this case the standards with which to measure deviations are familiar: 45,000 VSPs, 10,000 Sergeants, and 15,000 Marshals. VFBs are not actively considered since this category easily reaches a stable steady-state in all the five strategies under review. The ideal deviation is zero, and as with the other measures, outcomes are evaluated by averaging performance over given time intervals. The results from the 2001-2010 period for VSPs and Sergeants are not counted, since all strategies perform equally poorly. The poor performance is caused by the fact that these stocks begin with far less personnel than required by the steady-state objective.

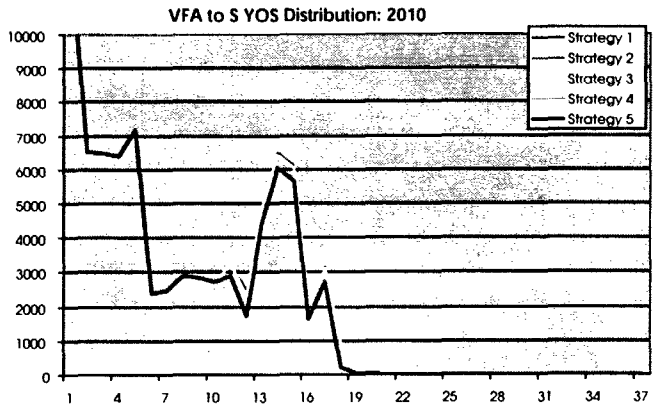
8.3 COMPARING OUTCOMES: SOME RESULTS

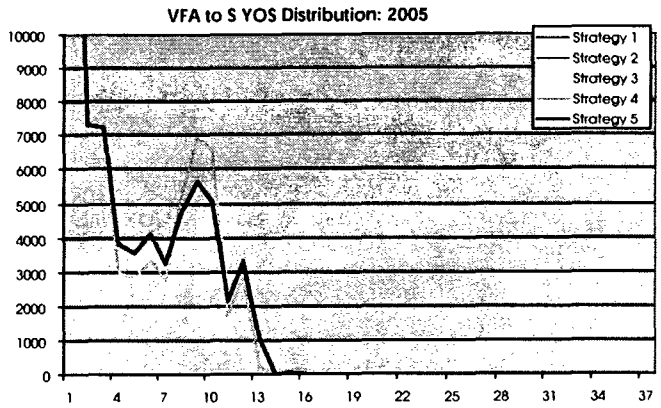
To give the reader an appreciation of how outcomes varied by strategy, this section presents a selected sample of charts summarizing performance in three areas: YOS distribution, promotion opportunities, and costs. The strategies are compared more systematically in the next section, and summary output for each can be found in Appendix H (this appendix also summarizes yearly costs).

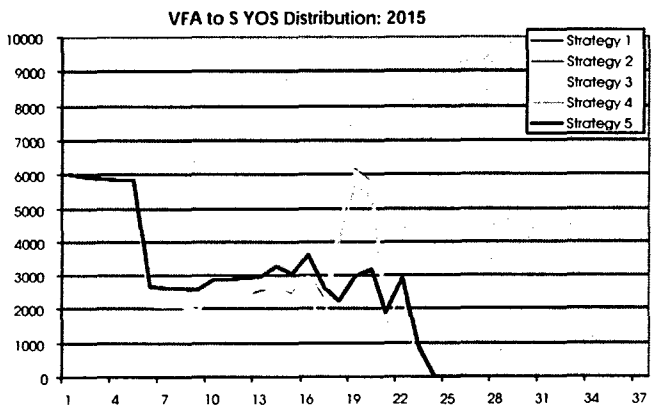
YOS distribution

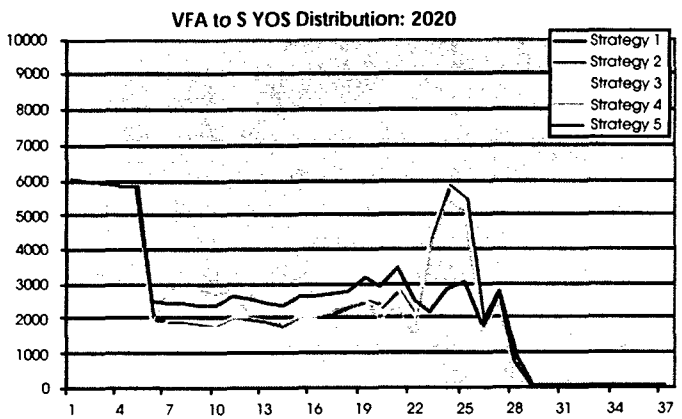
Figure 8.2 represents a series of snapshots of the YOS distribution at different points in the simulation (such distributions are then used to obtain average squared deviations from the ideal profile). It is apparent that strategies yield similar results in 2005, but Strategy 5 is successful at eliminating the spike by 2010 because of its aggressive early separation program. The spike continues unabated for all other strategies up until the mid-20s; from this period onward, Strategy 2's early separation program takes effect. But since this strategy eliminates the hump in a relatively short amount of time, it forces the system to create a new concentration of junior personnel in order to

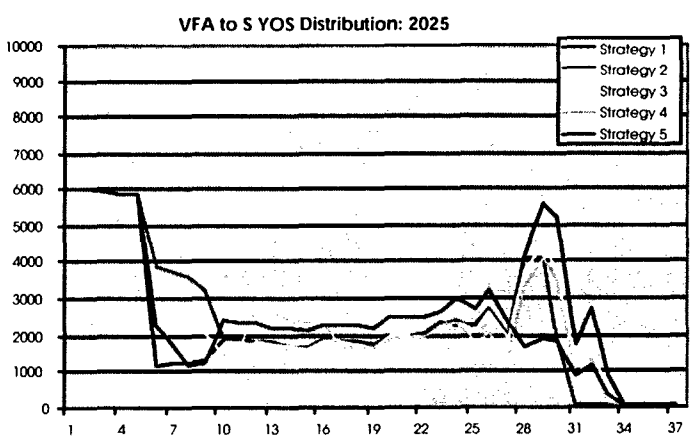
maintain the size of each category constant. The other strategies instead eliminate the spike more gradually. By 2030, only the base case YOS profile still shows a significant spike of very senior VSPs and Sergeants.











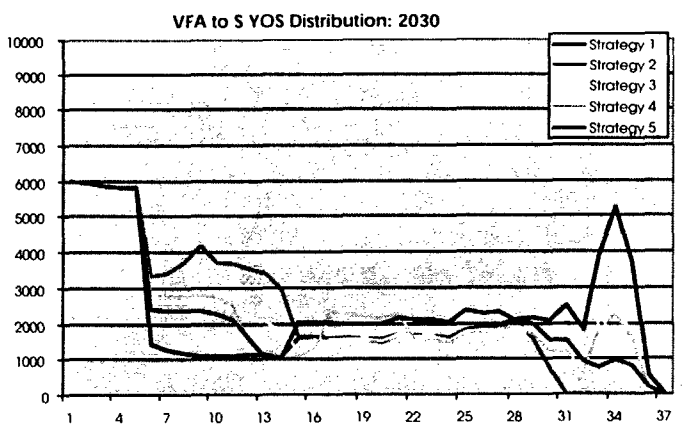
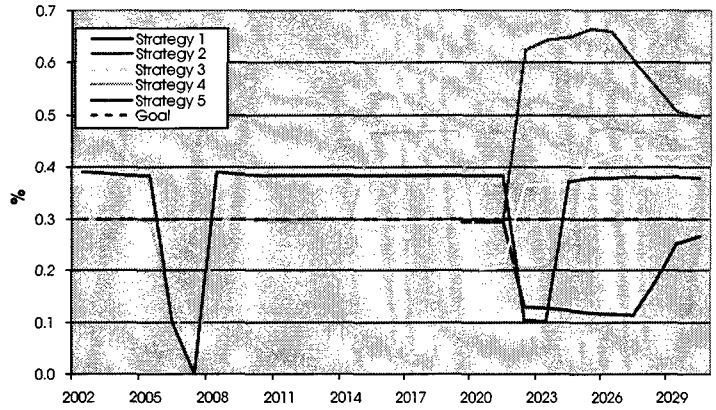


Figure 8.2 Evolution of VFA to S YOS profile for each strategy

Promotion opportunities

Figure 8.3 illustrates how the promotion rate from VFB to VSP has fared over time for the five strategies. As mentioned in Chapter 7, the 2006-2007 dip in promotion percentages is caused by the switch from a three-year to a five-year VFB term.

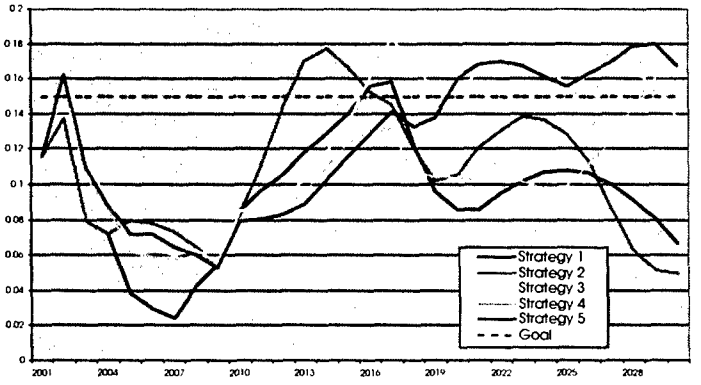
Figure 8.3 VFB to VSP promotions, as % of those eligible



Strategy 5 has a slightly greater promotion rate until the system reaches its steady-state, but then the percentage promoted drops considerably for two years before resuming its usual course. Strategies 1, 2, and 3 experience a similar drop, albeit to different degrees. Such a reduction in promotion opportunities reflects the fact that few individuals leave the VSP category once it reaches capacity in 2020, and few exits automatically imply few entries. Strategy 3 in particular reduces this fluctuation effectively. Strategy 2 instead shows an opposite pattern--inflows are very large in the mid-2020s as a large number of personnel leaving the VSP ranks (either to retire or to become Sergeants) needs to be quickly replaced to remain at the 45,000-soldier level. Strategy 1 has a similar overshoot soon after 2030 since personnel retires en masse at that point (not shown).

Figure 8.4 instead gives a sense of how promotion opportunities in the Marshals category varied by strategy. It shows that the base case strategy and Strategy 2 register the greatest swings in promotion tempo. No strategy does extremely well in the short term given the slow pace of exits from M4, but Strategies 3 and 5 bring the greatest degree of stability in the medium to long term.

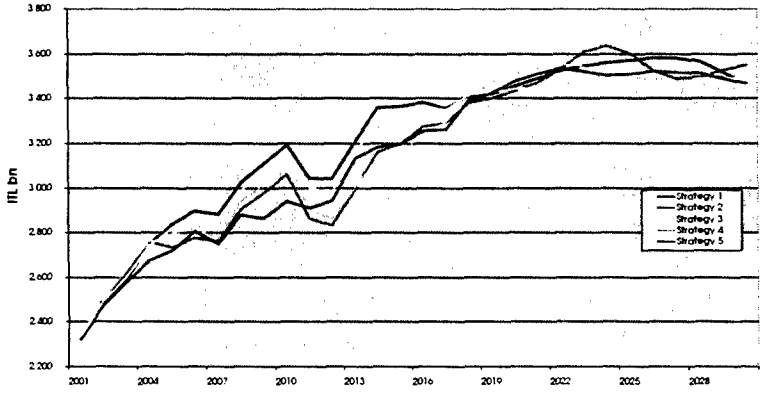
Figure 8.4 M3 to M4 promotions, as a % of those eligible



Costs

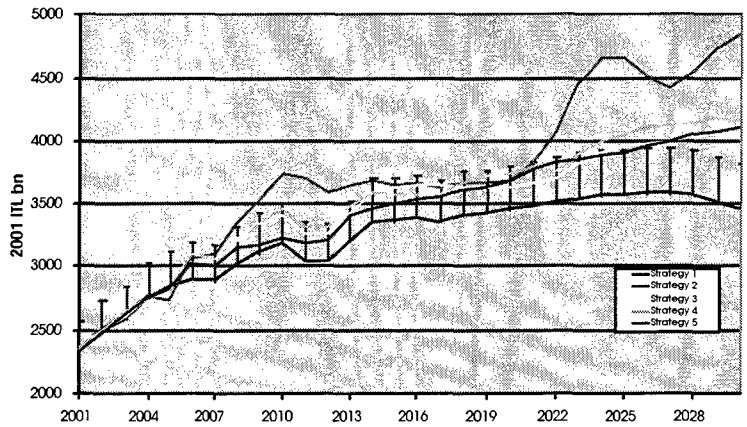
In terms of active-duty personnel costs, Strategies 2, 3, 4, and 5 are more economical for most simulation periods since the gradual early separations decrease the number of senior soldiers in service (see Figure 8.5).

Figure 8.5 Active-duty personnel costs



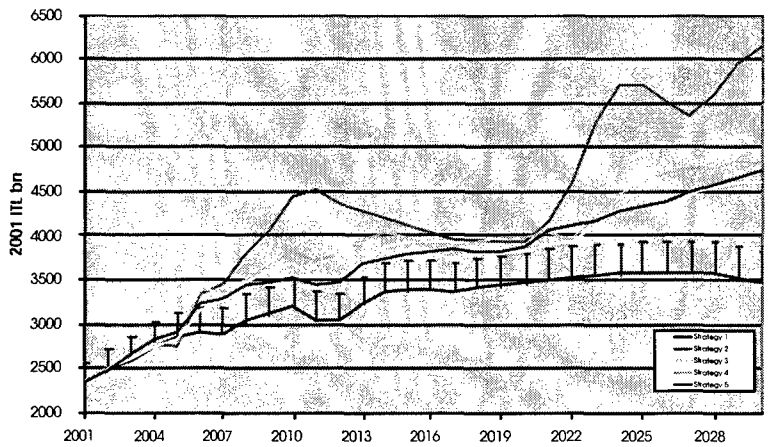
When the costs of early separation are included, however, aggregate personnel costs are clearly higher than in the base case for all alternative strategies (see Figures 8.6 and 8.7). A lower-bound cost for early separation (separation multiplier: 15%) maintains strategies 3, 4 and 5 within 10% of the base case costs during every year of the simulation (the vertical lines above the base case cost curve indicate an upward variation of 10%).

Figure 8.6 Personnel costs, lower separation bonus



Assuming a higher early separation cost (separation multiplier: 30%) creates greater deviation, especially in the late 2020s. Strategies 3 and 5 remain closest to the base case. The greatest cost differentials vis-à-vis the base case occur toward the late 2010s, as a significant number of Marshals separates early, and from the early 2020s onward, when individuals in the VSP and Sergeant "humps" begin to retire. Strategy 2 is by far the poorest performer under all cost assumptions, in large part because it retires individuals aggressively and within a limited number of YOS.

Figure 8.7 Personnel costs, higher separation bonus

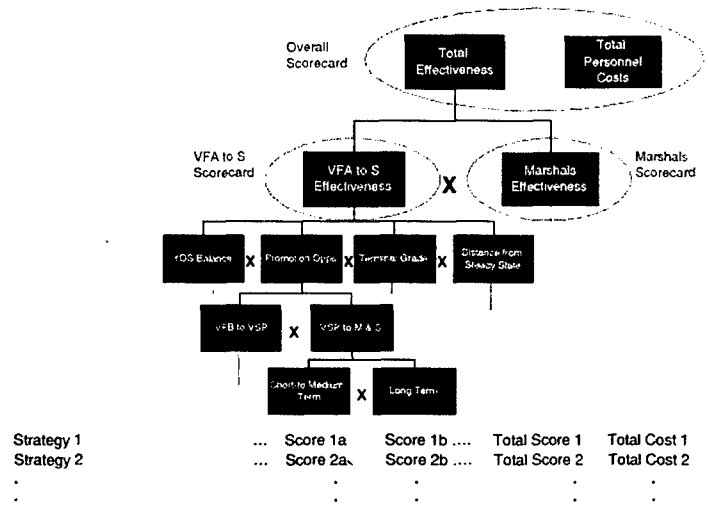


8.4 SCORECARD ANALYSIS: SOME CONTEXT ON THE PROCESS

As mentioned in Chapter 5, scorecards enable the ranking of strategies across multiple measures of effectiveness over several time periods. The *Dynarank* decision support tool was employed to build individual scorecards; the analysis also made use of its built-in

functions to compare the results across different weight configurations. Three scorecards were devised. Two cover the results from each sub-model--one for VFA to Sergeants, the other for Marshals. The aggregate effectiveness measure on the right-hand side of each scorecard summarizes strategy performance for that sub-model. These aggregate effectiveness measures were then used to create an overall effectiveness measure in a higher-level scorecard. The overall level scorecard also includes the measure of cost (i.e., the NPV of the 30-year cost stream), so that cost-effectiveness rankings can be performed. Figure 8.8 summarizes the structure of the scorecard framework.

Figure 8.8 Scorecard hierarchy



Comparing performance across different weight configurations

One of the key objectives of the comparative analysis is to explore how different assumptions and weightings affect the relative ranking of options (Thie et al., 2001, p. 63). To reflect this, results for each scorecard are reported in the form of multiple ranked lists, which are created by systematically varying the weights on the measures of effectiveness. These lists are then examined for commonalty and differences (Hillestad and Davis, 1998). Dynarank greatly aids this process with its Rank Sheet and Result Sheet functions, which accumulate alternative weight configurations--also known as "views." The simplest of such accumulations is the Rank Sheet, which keeps a count of how strategies fare compared to others across multiple views. In the Results sheet, the aggregate utility (and cost, where relevant) of all options corresponding to alternative sets of weights are stored, producing a

"meta-weighted average" of the aggregate effectiveness results for each strategy across views.[131]

For the purposes of this analysis, seven views were used in addition to the default weight configuration. These are summarized in Table 8.4.

Table 8.4 Views and their impact on scorecard weights

View type	*Weight configuration*
Default	2. Performance weighted equally across measures
Short-term focus	3. All 2011-2030 performance assigned a weight of "0"
Medium-term focus	4. All 2001-2010 and 2021-2030 performance assigned a weight of "0"
Long-term focus	5. All 2001-2020 performance assigned a weight of "0"
YOS balance focus	6. All YOS balance performance weighted equal; all else is assigned a weight of "0"
Promotion opps focus	7. All promotion opps performance weighted equal; all else is are assigned a weight of "0"
Terminal grade balance focus	8. All terminal grade balance performance weighted equal; all else is are assigned a weight of "0"
Distance to steady-state focus	9. All distance to St-St performance is weighted equal; all else is assigned a weight of "0"

Depending on the decision-maker's institutional position and role, he or she may be interested in different views. For instance, members of Parliament and officials in the budgeting office may place far more emphasis on short-term outcomes since their time horizon does not typically extend over decades. On the other hand, Army manpower planners would discount less the long-term consequences of decisions taken today, since one of their goals is to design an effective and sustainable steady-state force. Personnel managers within the armed forces would deeply care about promotion opportunities and terminal grade balance, given the impact these two measures can have on effort supply and soldier quality. General Staff officers in charge of assigning soldiers to particular units or occupational groups may instead be more concerned with strategy performance on the YOS balance measures at all times,

[131] The results from the Rank and Results Sheets should be correlated, but not always. The Results Sheet shows which options are better on average, rather than which options appear most often with high rankings (Hillestad and Davis, 1988).

since experience correlates with different training and skill requirements.[132]

8.5 VFA TO SERGEANT SCORECARD RESULTS

The scorecard summarizing the results from the VFA to Sergeant sub-model is shown in Figure 8.9. The content of each cell is taken from a linked Excel workbook measuring the deviation of each strategy from each target (which is in turn normalized on a 1 to 100 scale).[133] The results are color-coded with a stoplight pattern: shades of red indicate poor performance, shades of yellow instead signify average performance, while shades of green are signs of good performance.

The scorecard in Figure 8.9 represents the default case in which all weights for all measures of effectiveness equal one. The aggregate column at the right-had side of the scorecard, therefore, represents a simple average in which all cells count to the same degree. In this case it is apparent that strategy 4 and 5 are tied in terms of aggregate effectiveness, Strategy 3 is a relatively close second, while Strategies 1 and 2 are clearly inferior. All the alternative strategies prove to be better than the base case, however.

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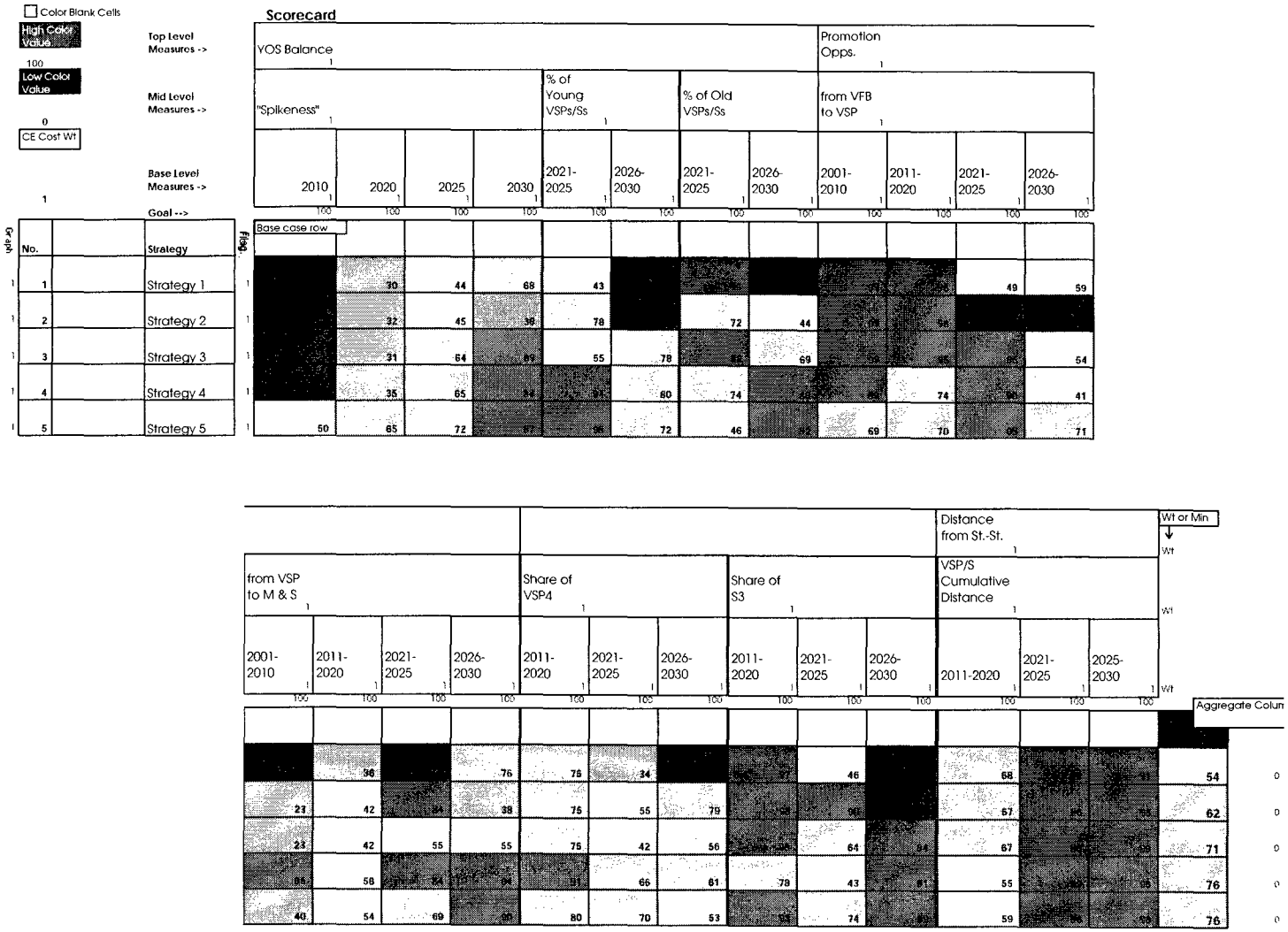
[132] To be sure, the views listed in Table 8.3 do not represent the full spectrum of relevant possibilities. On the other hand, they are varied enough to provide a sense of how the strategies perform under different sets of preferences (results from several other of the potentially infinite weight combinations did not add a greater level of insight into the problem). In future analyses, more accurate weight configurations can be obtained through the questionnaire-based methodology described in Thie *et al.* (2001).

[133] This worksheet is in turn linked to individual strategy workbooks which summarize the raw data for each run.

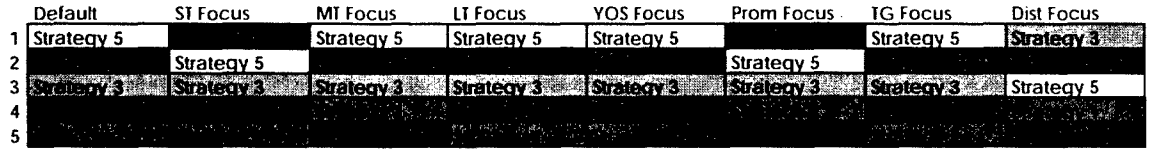
Figure 8.9 VFA to Sergeants scorecard



Rank Sheet analysis

Figure 8.10 summarizes how the five strategies rank in terms of aggregate effectiveness under the eight different views. To help identify patterns across views, the strategies are color-coded.

Figure 8.10 Rank Sheet summary for the VFA to Sergeants scorecard



The leftmost column in Figure 8.10 reflects the scores under the default view (Strategy 5 ranked first because it is actually ahead of Strategy 4 by a few decimal points). Strategy 5 consistently ranks as either first or second in all views except for the last (distance focus), in which it places third. Its score on the distance to steady-state measure is not high because its transition path to equilibrium is slower than that of other strategies. However, it does particularly well in reducing the "spikeness" of the YOS distribution and in keeping the number of VSP4s low. Strategy 4 is a consistent runner-up, and not surprisingly ranks first in the promotion focus view (it also fares worse than Strategy 5 in the distance focus view).

Results Sheet analysis

The results sheet accumulated the aggregate effectiveness results for the eight views mentioned above. The entire record of these results (and those of the other two scorecards) can be found in Appendix I; the table below only shows the summary values. These represent the weighted average of all the aggregate effectiveness values for each view.[134]

[134] For parsimony, all weights across views are kept equal, so that the aggregate utility columns represent a simple average. This reflects the reasonable assumption that all views are equally important.

Figure 8.11 Result Sheet summary for the VFA to Sergeants scorecard

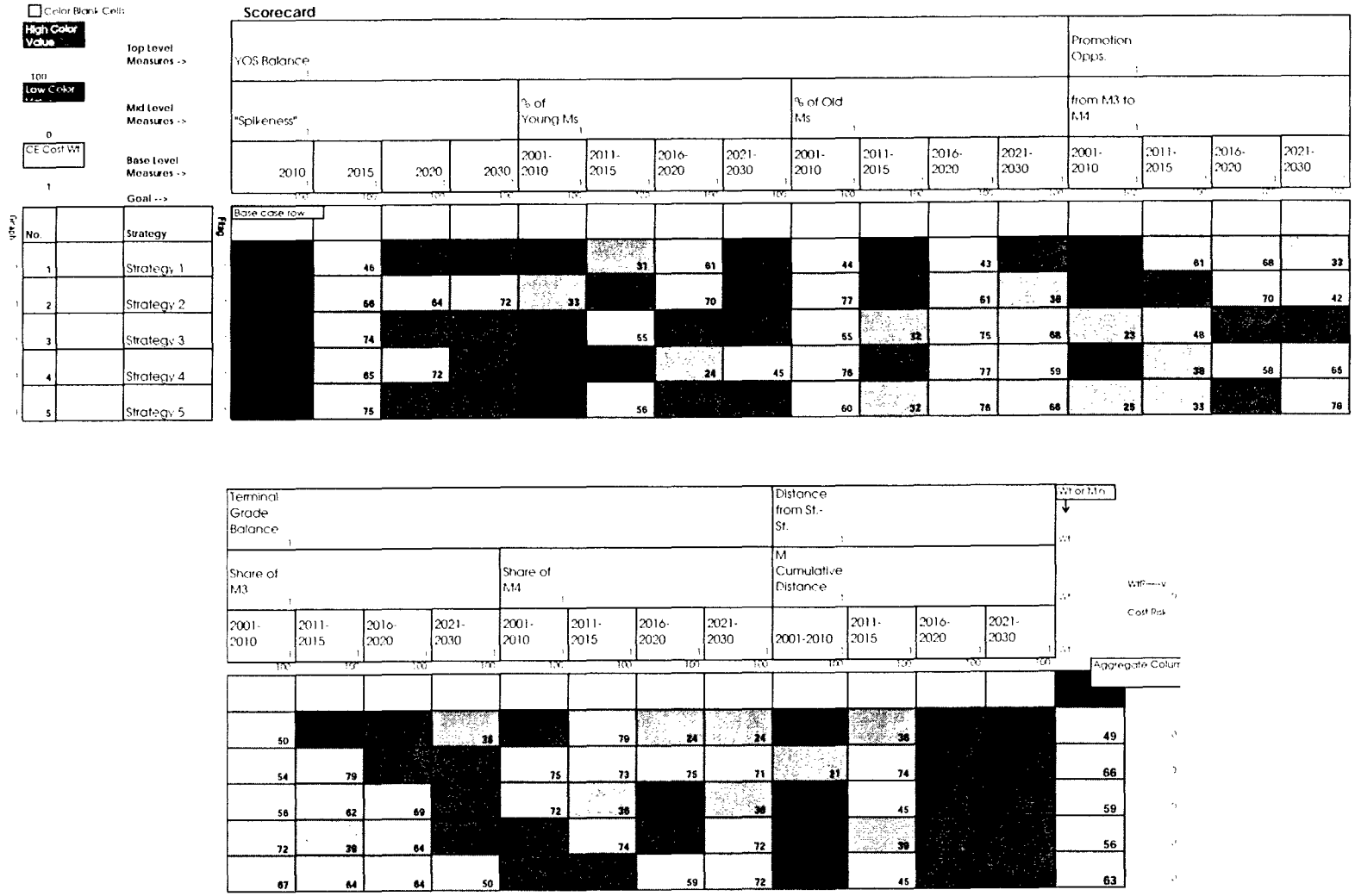
No.		Strategy	Eff. Rank	Agg. Utility
1		Strategy 1	5	51.70
2		Strategy 2	4	58.24
3		Strategy 3	3	65.70
4		Strategy 4	2	71.88
5		Strategy 5	1	72.93

Figure 8.11 lends support to the conclusion that Strategy 5 is marginally better than Strategy 4 across a wide combination of weights. The fact that Strategies 3, 4 and 5 clearly surpass the remaining two strongly implies that gradual early retirement programs significantly improve outcomes.

8.6 MARSHALS SCORECARD RESULTS

Interestingly, the results from the Marshals sub-model are relatively different from those shown above. Figure 8.12 on the next page shows that, when all weights are kept equal for all time periods, Strategy 2 stands out as the one with the highest score. Strategy 5 is a close second, while Strategies 3 and 4 score lower. As in the VFA to Sergeants scorecard, Strategy 1 is clearly performs less well.

Figure 8.12 Marshals scorecard



Rank Sheet analysis

To ascertain whether this pattern held under different weight assumptions, the strategies were ranked with the same set of views used in Table 8.3. Strategy 2 ranks high across most views (see Figure 8.13), underscoring the fact that an aggressive retirement program can work better for a force that needs to be aggressively downsized. However, such an approach works far less well once the force reaches a stable steady-state--Strategy 2 scores particularly badly in the long-term focus view (2021-2030) since it creates significant imbalances in age category distribution and promotion opportunities. Strategy 5 ranks high on the first five views, although it occupies third place for those weight configurations that place a premium on promotion opportunities, terminal grade share, and distance to the steady-state.[135] Strategy 4's VSP-oriented promotion focus actually proves to be a burden for Marshal promotion opportunities. The relatively high vertical accessions into this category eventually create a sizable concentration of personnel in the M3 grade, and only a small part of this is eventually promoted to M4.

Figure 8.13 Rank Sheet summary for the Marshals scorecard

	Default	ST Focus	MT Focus	LT Focus	YOS Focus	Prom Focus	TG Focus	Dist Focus
1	Strategy 2		Strategy 2	Strategy 3	Strategy 2	Strategy 3	Strategy 2	Strategy 2
2		Strategy 2			Strategy 5	Strategy 2		
3	Strategy 3	Strategy 3	Strategy 3		Strategy 3			
4				Strategy 2		Strategy 4	Strategy 3	Strategy 3
5	Strategy 1	Strategy 1	Strategy 1	Strategy 1	Strategy 1	Strategy 1	Strategy 1	Strategy 1

Result Sheet analysis

The result sheet confirms the fact that Strategy 2 performs relatively well across all views, and that Strategy 5 is the only other strategy that remains relatively close in terms of overall score. Strategy 1 clearly proves to be the most inferior, while strategies 3 and 4 are relatively mediocre performers.

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[135] Strategy 5's M3 to M4 promotion rule (which limits the number of accessions to M4 prior to the eighth year of service to 10% of the total) proved to be largely ineffective in improving performance on the terminal grade measures. This is largely due to the fact that the marginal effect was rather small, since in the default setting only 30% of promoted individuals has less than eight YOS.

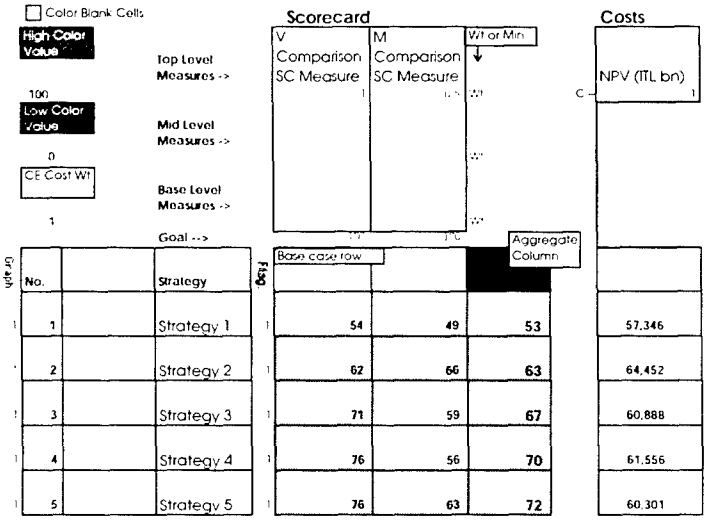
Figure 8.14 Result Sheet summary for the Marshals scorecard

No.		Strategy	Eff. Rank	Agg. Utility
1		Strategy 1	5	48.40
2		Strategy 2	1	64.38
3		Strategy 3	3	58.37
4		Strategy 4	4	55.94
5		Strategy 5	2	62.41

8.7 OVERALL SCORECARD RESULTS

The overall scorecard is simpler than its two previous counterparts. As shown in figure 8.15, its only two measures of effectiveness summarize the aggregate effectiveness from the VFA to Sergeants and Marshals scorecards. In addition, this scorecard also provides the NPV of the 30-year cost stream (using a discount rate of 3.5%) for each strategy.[136]

Figure 8.15 Aggregate scorecard (effectiveness and costs)



The default view presented in Figure 8.15 assumes that the aggregate effectiveness of Marshals is weighted half as much as the one of the VFA to Sergeants scorecard. Using this weight configuration,

[136] The early separation cost multiplier used in Figure 8.15 is 15%.

Strategy 5 ranks first, with Strategy 4 as a close finisher. Strategy 1 is by far the worst performer, while Strategies 2 and 3 occupy middle ranking positions. The costs are lowest for Strategy 1, since in this case there are no early separations. They are highest for strategy 2; out of all the gradual early separation strategies, Strategy 5 carries the lowest cost, closely followed by Strategy 3.

Rank Sheet analysis

The alternative views in this case consisted of a different set of weights placed on the Marshals results; aside from the default value of 0.5, Marshals scores were weighted as follows: 0.2, 0.4, 0.6, 0.8, 1.[137] This range of rankings could conceivably cover the preferences of those that place little emphasis on this category, as well as of decision-makers who would instead place equal weight on the results of both sub-models. As Figure 8.16 reports, the Strategy rankings *by effectiveness* are robust across the set of views. Strategy 5 is always the highest, followed by Strategies 4, 3, and 2. Strategy 1 consistently ranks as the worst performer.

Figure 8.16 Rank Sheet summary for overall scorecard: by effectiveness

	Default	MW:.2	MW:.4	MW:.6	MW:.8	MW:1	MW:1
1	Strategy 5	Strategy 5	Strategy 5	Strategy 5	Strategy 5	Strategy 5	Strategy 5
2	Strategy 4	Strategy 4	Strategy 4	Strategy 4	Strategy 4	Strategy 4	Strategy 4
3	Strategy 3	Strategy 3	Strategy 3	Strategy 3	Strategy 3	Strategy 3	Strategy 3
4	Strategy 2	Strategy 2	Strategy 2	Strategy 2	Strategy 2	Strategy 2	Strategy 2
5	Strategy 1	Strategy 1	Strategy 1	Strategy 1	Strategy 1	Strategy 1	Strategy 1

The results do not change when the ranking is done on the basis of *cost effectiveness* when assuming an early separation cost multiplier of 15%, as shown in Table 8.17.

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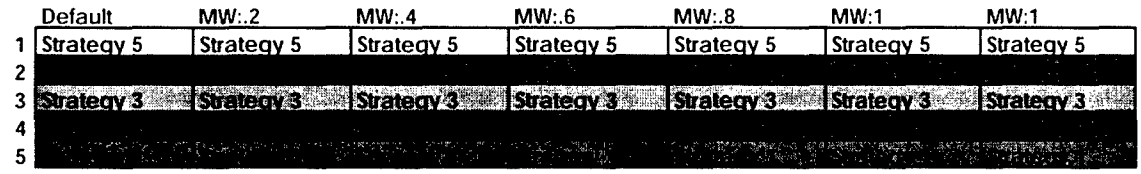
[137] For the sake of parsimony, aggregate effectiveness figures from the subordinate scorecards reflect the default view. The reader can easily infer from the previously reported results how overall effectiveness would be affected by other possible weight configurations.

Figure 8.17 Rank Sheet summary for overall scorecard: by cost-effectiveness (ES multiplier: 15%)



	Default	MW:.2	MW:.4	MW:.6	MW:.8	MW:1	MW:1
1	Strategy 5	Strategy 5	Strategy 5	Strategy 5	Strategy 5	Strategy 5	Strategy 5
2							
3	Strategy 3	Strategy 3	Strategy 3	Strategy 3	Strategy 3	Strategy 3	Strategy 3
4							
5							

Only when the early separation cost multiplier is estimated at 30% does Strategy 2 prove to be less cost-effective than 1. That is, with high early separation cost assumptions Strategy 2's marginal improvement in effectiveness over the base case is outweighed by its very large increase in costs.

Results sheet analysis

Figure 8.18 shows the summary of the Results Sheet for effectiveness, cost, and cost-effectiveness across the different views (the data reported here assume a 15% early separation multiplier). The result sheet analysis confirms what was observed above.

Figure 8.18 Results Sheet summary for overall scorecard

No.		Strategy	Eff. Rank	Cost Rank	CE Rank	Agg. Utility
1		Strategy 1	5	1	5	52.44
2		Strategy 2	4	5	4	63.57
3		Strategy 3	3	3	3	66.83
4		Strategy 4	2	4	2	69.16
5		Strategy 5	1	2	1	71.53

8.8 SENSITIVITY RUNS

As mentioned before, both the absolute and relative performance of each strategy could potentially change if the target values for the measures of effectiveness were to be altered. In order to verify the sensitivity of the results reported above to different assumptions on what constitutes a good outcome, two additional sets of scorecards were constructed. The first reflects scores that are obtained with target values that are lower than their default setting; the second set instead

contains the scores that would result from higher values. The former can be understood as being less "ambitious" since in many cases lowering the targets brings these closer to the values recorded for the base case (thereby improving the score of Strategy 1 relative to others). Similarly, the higher target values can be seen as more ambitious. Tables 8.5 to 8.7 provide information on the targets that were changed along with their high-low range. Such a range is likely to encompass most of the values that Army planners would consider as reasonable targets for the force during and after the transition to the steady-state.[138]

Table 8.5 Age group shares: alternative target values

Category/Age group	Default target	Less ambitious target	More ambitious target
VSP & Sergeants			
Young (7 to 16 YOS)	40%	35%	45%
Old (27 to 36 YOS)	25%	30%	20%
Marshals			
Young (1 to 11 YOS)	33%	30%	35%
Old (24 to 36 YOS)	33%	35%	30%

Table 8.6 Terminal grade shares: alternative target values

Terminal grade share	Default Target	Less ambitious target	More ambitious target
VSP4	40%	45%	35%
S3	20%	25%	15%
M3	35%	30%	40%
M4	20%	25%	15%

Table 8.7 Promotion percentages: alternative target values

Promotion rate	Default Target	Less ambitious target	More ambitious target
From VFB to VSP	30%	25%	35%
From VSP to M and S	3%	2.5%	3.5%
From M3 to M4	15%	12.5%	17.5%

[138] This range could also be easily expanded and/or contracted in future analyses to better reflect changes in preferences or additional information on target values.

The results for these runs across the sets of views explored in section 8.7 are documented in Appendix J. They point to the fact that with both the more and less ambitious sets of targets, the three gradual early retirement strategies remain superior to Strategies 1 and 2. With less ambitious targets, Strategy 2 is the overall worst performer on both an effectiveness and cost-effectiveness basis. Such a finding makes intuitive sense, since the drastic changes to the retirement age called for by Strategy 2 are less necessary when the set of targets is more favorable to the status quo. The differences between Strategies 3, 4 and 5 instead shrink considerably, and the results from these become virtually indistinguishable (Strategy 5 remains the most cost-effective overall under all save for one weight configuration, however).

Not surprisingly, Strategy 1 is the worst performer under the more ambitious set of targets. Strategy 5 is more clearly ahead of all others under different weight configurations, although Strategies 3 and 4 are not overly distant in terms of their cost-effectiveness rank. On aggregate effectiveness alone, Strategy 2 is also a solid performer--this is not surprising, since its aggressive separation program brings about more radical (and more highly-valued) departures from the base case.

9. CONCLUSIONS AND POLICY IMPLICATIONS

This chapter summarizes the principal policy implications of the research, as well as the conclusions that can be drawn from these. It begins by highlighting the key insights from the model-based analysis. The discussion then focuses on a series of findings on the personnel management processes explored in the first chapters of the dissertation--as argued below, these are intimately related to modeling outcomes. The final section leaves the reader with a series of policy prescriptions and an agenda for future work in this area.

9.1 CONCLUSIONS FROM THE MODEL-BASED POLICY ANALYSIS

The simulation results indicate that *implementing the Army transition plan--and the current Army long-term manpower mix targets--is likely to lead to an unbalanced force.* The principal drivers of personnel imbalances include: (1) persistent concentrations of soldiers in a small number of years of service; (2) an overly senior career force in the medium-to-long-term; (3) extended stays in terminal grades; and (4) irregular promotion tempo.

In turn, these imbalances could create personnel management difficulties as well as age/skill mismatches that could ultimately affect force readiness (see Chapters 3 and 4). These potential problems are not being recognized explicitly at the moment, in large part because the system is not displaying the full spectrum of stresses and shortfalls that are likely to emerge over time. In the absence of corrective actions, problems would become more acute for Marshals prior to 2020, while imbalances in the VSP and Sergeant force would reach their peak in the 2020s. Importantly, all the existing problems and shortfalls are greatly amplified by:

- the considerable length of military careers, and
- the Army's steady-state, which locks the system into a very senior personnel mix.

The impact of long military careers--and ways to reduce it

It is no coincidence that all the alternative strategies explored in Chapter 8 focus on shortening military careers. In fact, the model-based policy analysis has shown that career length is by far the most important policy lever. Such policy leverage is determined by the fact that the current--and significant--personnel imbalances can only be effectively tackled through exits. Changing promotion rules and timing appear to be have an impact only at the margin or when the system is in a stable equilibrium.

Chapter 8 identified Strategy 5 as the alternative that consistently proves to be most effective *and* cost-effective. Strategy 5 is also the least costly strategy aside from the base case.[139] The fact that Strategies 3 and 4 are relatively close to 5 in terms of outcomes across a wide range of assumptions underscores the importance and effectiveness of *gradual* early separation programs. Therefore, while it is not possible to characterize Strategy 5 as the "strictly optimal" approach, the analysis shows with a great degree of confidence that *any successful transition will have to rely on gradual early separation programs.* These will have to be surely implemented early on for the Marshals force, and after the achievement of the steady-state mix for the Sergeant and VSP forces. VSP separations over the next decade will also be necessary if the Army wishes to place a great deal of emphasis on reducing substantial spikes in the YOS distribution.

The steady-state's career-intensive force mix acts as an analytical "straightjacket"

Strategies 3 to 5 bring about similar outcomes because they all share the same steady-state target mix. This in effect poses a structural constraint on the potential variation that can exist between

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[139] A program that encourages early exits would obviously add to total budget costs, although one should also take into account the fact that an older force could well be less productive and therefore effective (Asch and Warner, 1994). Moreover, this analysis has adopted conservative estimates of separation costs. It is conceivable that such costs could be kept to a minimum with a series of initiatives, such as rotation programs that place a fraction of mid-career and senior Army personnel into civilian public sector organizations.

strategies, and on the ways in which imbalances can be corrected. In fact, part of the problem may lie in the steady-state goals themselves. A more junior force could be easier to manage, and possibly cheaper, in the long run.

Choosing alternative force mixes: an initial thought experiment

An in-depth comparison of alternative steady-states goes beyond well the scope of this dissertation. However, a last set of runs serving as a thought experiment was devised in order to consider the impact of a more junior steady-state force with:

- 50,000 VFBs;
- 30,000 VSPs;
- 12,000 Sergeants;
- 8,000 Marshals.

This is a significantly more junior force--and one that is more pyramidal than the current steady-state. It calls for a more prominent role for VFBs,[140] and a drastic reduction in the number of Marshals from today's 25,000-level. One sample strategy was designed to explore the cost implications of the alternative mix. This strategy brings the system to the new steady-state in 2020 by aggressively separating Marshals and by lowering the VSP intake (see Appendix K for a fuller description of this strategy and its outcomes).[141]

Figures 9.1 and 9.2 below indicate the approximate cost implications of a more junior steady-state. They show that once in equilibrium, active-duty costs of a more junior force are significantly lower than the costs associated with strategies 1 (the base case) and 5.[142] Adding early retirement costs to the analysis (assessed with the 15% separation multiplier) makes the more junior steady-state more

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[140] The VFB/VSP breakdown of this steady-state more closely approximates the 60/40% target specified by Grosso (1998).

[141] The point of this experiment is not to validate a different steady-state, or a particular strategy's ability to meet a new set of requirements. Comparing strategy outcomes across steady-states would also be inappropriate, since the standards for evaluating performance would vary according to the force mix.

[142] These do not include reduced retirement costs, which would make a more junior force even more attractive from a financial standpoint.

expensive in the short-to medium run, but potentially cheaper in the long run once the current humps are processed out of the system.

Figure 9.1 Hypothetical vs. current steady-state: active-duty costs

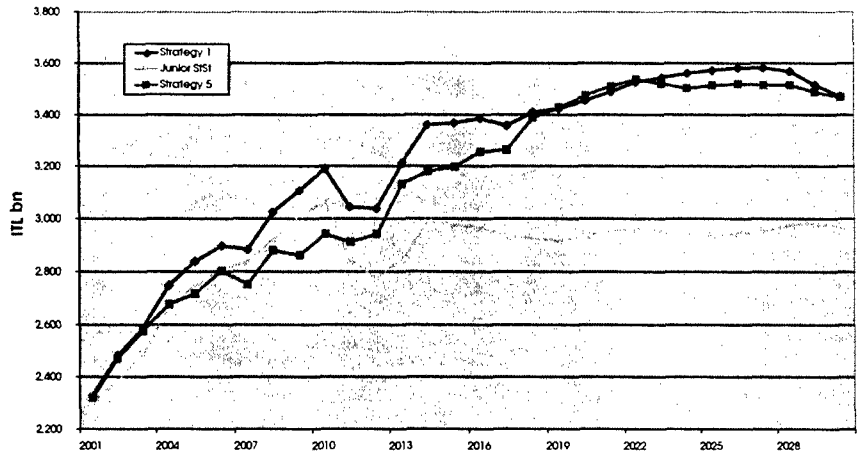
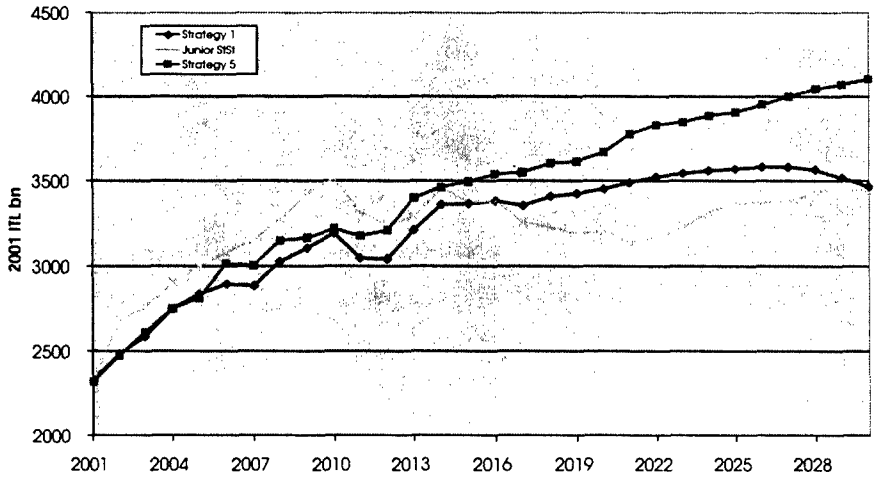


Figure 9.2 Hypothetical vs. current steady-state: total costs (15% separation multiplier)



A more junior force could also be more productive, to the extent that it better matches its experience mix with the tasks to be performed. Eventual long-run cost savings could also be reinvested to increase productivity--either by hiring higher-quality soldiers (and compensating them accordingly) or by acquiring more modern capital equipment and allocating more resources to training. Preliminary runs also point to the fact that a more junior force would also be flexible--

changes in overall force size could be managed relatively easily by relying primarily on changes in the VFB force. Given the limited length of service for junior personnel, the system could "digest" most changes within five years by altering VFB intakes--instead of the more than thirty years that would be required for a natural turnover in the career personnel categories.[143]

Given the potential advantages of a more youthful force, why has the Army opted for the current steady-state? It appears that the factors constraining the Army's choices are overwhelmingly supply-side, and possibly short term. One is the lack of success on the hiring front: to shield force management from the vicissitudes of the recruitment environment, planners have chosen to rely more heavily on career volunteers. The other rationale stems from the assumption that prospective recruits seek lifetime employment--and a greater share for non-VFB soldiers signals greater career opportunities.

These factors are serve as powerful constraints on Army manpower planning, and certainly deserve to be addressed. That being said, *the current solution to the recruitment problem could well be the least cost-effective in the long run.* As mentioned in the next section, the Army could remedy this and other supply-side shortfalls by improving a series of personnel management processes.

9.2 LIMITATIONS OF CURRENT PERSONNEL MANAGEMENT PROCESSES

The discussion in chapter 2, 3 and 4 identifies limitations in three critical personnel management areas which, if addressed, could enable the Army to relax current supply-side constraints and base its long-term plans on actual manpower requirements:

- the Army is taking a passive attitude toward recruitment, and its efforts are hampered by a series of bureaucratic problems;

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[143] To be sure, increases and decreases in overall force size would have to be distributed proportionately across ranks (Grissmer et al., 1995). However, a force with relatively more VFB personnel could amortize changes more easily and quickly than ones with greater numbers of career soldiers.

- personnel policy is rendered less effective by lack of differentiation among prospective recruits and active-duty personnel--this trend is especially evident in the Army's compensation and promotion systems;
- in turn, such lack of differentiation is directly related to the paucity of systematic and reliable data on how soldiers respond to different incentives at the point of recruitment and beyond.

Passive attitude and bureaucratic problems

The inefficacy of current recruitment problems is in large part due to the system's bureaucratic inflexibility and unfriendliness. As mentioned in Chapter 2, the support given by the Army to potential and actual VFB candidates is minimal. Indeed, current recruitment procedures inhibit the Army's ability to reach out to potential recruits since there is little direct interaction between the service and the prospective applicant. *To compound the problem, a large fraction (roughly 50%) of the relatively few individuals who signal their interest in joining the military leave the selection process in its early stages.* This implies that for each recruitment cycle the Army faces the stark choice of either (1) meeting its quantitative quotas by adopting laxer standards, or (2) maintaining higher standards only to subsequently face manpower shortfalls.

Recruiting effectiveness has also been hampered by lack of coordination between the Ministry of Defense (MoD) and other institutions, as well as between different MoD bureaucracies. For instance, the police forces are not receptive to the notion that their recruiting processes need to explicitly consider Army personnel requirements, and have been reluctant to abide by the yearly recruitment quotas assigned to them. It is also becoming apparent that other public sector agencies and municipalities, which by law are required to give preferential access to individuals who have finished their first term, are also ignoring such regulations. In addition, there seem to be bureaucratic obstacles to better coordination within the Army recruiting establishment itself. For instance, sources within the recruitment promotion agency (APR) have indicated that the Ministry of Defense

committee responsible for implementing the thrice-yearly contests as uncooperative and unwilling to promptly share information.

Little differentiation among different types of personnel

It is impossible to ascertain the degree to which the Army is currently compromising on quality in order to meet quantitative goals, since there are no formal methods for differentiating among personnel with varying abilities and/or skill sets. Indeed, the Army is adopting a "brute force" approach during the selection process by administering a general culture exam designed to winnow the applicant pool before aptitude and medical tests. Some Army officers have expressed concern that the screening exam may not be successful in identifying the most suitable candidates. And since a standard quality scale is not used for planning purposes, it becomes impossible to set recruitment goals for different quality categories. In fact, the Army does not appear to be systematically and proactively attempting to attract with targeted incentives individuals who are (1) of a higher quality or (2) are considering committing themselves to particular skill areas with. The undifferentiated way in which the Army distributes its end-of-term exit bonus is a case in point.

The same lack of differentiation also affects career force management. The Army is making personnel management decisions today which, given the considerable length of military careers, can reverberate for decades. The high rates of promotion to the VSP force over the last six years, as first discussed in Chapter 3, is one cause for concern. Given that upstream recruitment standards have been viewed by several Army officers as being lax at times, there is no guarantee that the nearly 20,000 VSPs currently in service have all the necessary characteristics (in terms of motivation and quality) to perform at high levels for the remainder of their relatively long career. This potential problem could become especially pressing in the face of slowing promotion tempo and long permanence in terminal grades. Moreover, the absence of performance-related pay, along with the excessive bureaucratization and grade inflation current affecting the personnel evaluation systems (Malfe', 1998), is likely to provide

another disincentive to increased effort supply and productivity. Taken together, these repercussions could be substantial, since as mentioned in Chapters 2 to 4 personnel characteristics such as quality and occupational specialty play a large role in determining overall productivity--and cost.

Insufficient understanding of behavioral responses to various incentives

The absence of a differentiated approach to personnel management is related to the paucity of systematic and reliable data on how soldiers respond to different incentives at the point of recruitment and beyond. There do not seem to be any econometric estimates of enlistment supply as a function of individual characteristics and recruitment incentives. Testing and evaluation of some promotional activities has occurred, but not with the necessary rigor to guarantee the validity of such tests. Without a fuller understanding of these phenomena, it will be impossible to identify an optimal, cost-effective policy mix.

Lack of standardized data on the quality of prospective recruits also limits the conclusions that can be reached regarding the adequacy of compensation (pecuniary and otherwise) and human capital incentives. As shown in Table 2.3, pay for VFBs does not to appear to be grossly inadequate compared to the civilian income distribution of military-age youth--especially if one factors in the end-of-term bonus and the increase in pay as a result of out-of-area deployments.[144] But it also does not appear to be obviously sufficient to attract a large number of high-quality individuals, who are in theory more responsive to wage increases (especially in the underrepresented North, where youth wages are significantly higher).[145]

A sizeable portion of the incentive structure relies on non-pecuniary benefits. In fact, the guarantee of a secure job is believed by virtually all Army planners to be a critical policy lever. However, there is no way of knowing what the precise effect of this strategy is

[144] VFBs have a high probability of receiving deployment pay, since such deployments have been frequent in past years.

[145] Compounding this is the fact that military life is in several respects more rigorous than civilian life, and that the compensation system has to take this into account.

on high-quality youth recruitment.[146] It is also impossible at this stage to gauge the extent to which human capital development prospects offered by initiatives such as *Euroformazione* are having an effect on enlistment decisions. Nor can the impact of greatly expanding these incentives on recruitment be ascertained analytically.

It is equally difficult to measure the adequacy of the promotion and compensation systems used to manage the career force. The difficulties lie in the lack of data and on the fact that the transition context renders all currently available information less reliable for predicting the behavioral responses of the force in the medium and long term. Short of conducting experiments or more detailed analytical exercises, it is impossible to rigorously ascertain whether the inter-category pay differentials are sufficient to encourage highly able workers to produce enough effort and to seek promotions over the course of their careers. There is also no way of knowing to what extent the automatic nature of promotion within grades of the same category, and the absence of up or out rules, is hindering effort supply.

That being said, the sample of data gathered for this research indicates that the personnel system is coming under increased stress--primarily because it is ill-suited to cope with a growing number of individuals serving as enlisted personnel for the entire duration of their long careers. For instance, Army officials have cited examples of VSPs eligible for promotion to the Sergeant category who have declined this opportunity because the associated costs (e.g. relocation, risk of spouse unemployment if he/she is working) are not sufficiently offset by the higher level of pay or in-kind benefits. Given that the share of career soldiers will surely increase during the transition, it is very likely that current deficiencies will become even more apparent in the years ahead.

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[146] Moreover, the stable employment value proposition is probably more effective in areas of high structural unemployment and, since youth unemployment rates are much higher in the south of Italy, it may also help to exacerbate regional disparities among enlisted personnel.

Putting current limitations into perspective: lessons from the U.S. AVF experience

If not addressed, the shortfalls mentioned above could seriously undermine the chances of a successful transition to an all-volunteer force. At the same time, however, it is equally clear that some complications are almost inevitable in the early phases of such a large-scale endeavor. Even the United States military experienced a host of problems in the first decade of its transformation into an AVF. In fact, in the 1970s U.S. military personnel management was hampered by missed recruitment goals, high attrition, low troop morale, worsened pubic perceptions, disciplinary problems, and inaccurate (misnormed) enlistment tests (Eitelberg, 1996).

Over time, the U.S. military establishment was able to address these problems through a specific set of policy interventions and by building the institutional capacity to implement such interventions effectively. Policy improvements included establishing quality goals, developing a more comprehensive manpower research program, building a sophisticated job assignment system, re-engineering the recruitment process, investing in quality-of-life improvements, and increasing compensation and educational benefits (Thurman, 1996). Perhaps the most fundamental lesson from the U.S. experience is that given adequate resources and the institutional capacity to allocate them effectively, all manpower problems are manageable (Eitelberg, 1996). Italian Army planners should actively consider these lessons when seeking to improve the functioning of their personnel system, as mentioned below.

9.3 POLICY RECOMMENDATIONS

This research points to a number of recommendations that Italian Army planners should consider as they plan the transformation to an All-Volunteer Force. Some are directly related to the modeling results, while others are essentially suggestions for improving the current personnel management processes (based on data reported in Chapters 2-4).

Modeling-related recommendations

The Italian Army faces a fundamental choice: it could either (1) seek the best solution under the current target steady-state mix, or (2) contemplate other potential steady-states.

- *If the Army wishes to continue with the current set of long-term force targets, then it will have to rely on an early separation program to reduce effective career lengths.*

Such program needs to be implemented gradually in order to reduce the swings in personnel demand caused by the eventual exits of large concentrations of soldiers currently in the force, especially in the career enlisted and Sergeant grades. This is by far the policy measure with the greatest amount of leverage. Policy interventions that leave the system's basic properties unchanged--such as variations in promotion timing and percentages quotas between personnel categories--*cannot by themselves prevent the significant imbalances that would occur without early separations.*

- *The relatively narrow range of feasible outcomes arising from the model-based analysis indicates that the Army should explore the possibility of moving toward more junior steady-state force mixes.*

This dissertation does not seek to offer guidance on how the Army should decide between steady states; indeed, answering the question of what long-term force mix the Army should pursue is a full-fledged research endeavor in its own right. On the other hand, the findings reported here suggest that greater "out of the box" thinking is warranted, especially since more junior steady-states could well be cheaper, more flexible and more effective in the long run.

Personnel management recommendations

Long-term manpower planning decisions can be greatly facilitated by improving the current personnel management processes, and making them more attuned to the post-conscription era. Specifically, the data and

insights presented in Chapters 2 through 4 highlights the need to address some of the shortfalls in the way the Army manages its people through two broad initiatives:

- *First, make the recruitment process more proactive and applicant-friendly.*

Many of the problems that hinder Italy's transition to an sustainable AVF are directly related to the fact that potential supply of enlistments is not being successfully converted into actual supply. Given the cost-effectiveness of military recruiters in the U.S. context, the Army should explore how this tool might work in Italy.[147] One of the options to be considered would entail the establishment of a dedicated group of individuals who are responsible (and rewarded) for encouraging enlistments. In addition, the high attrition rates hampering the effectiveness of the current screening process could be reversed with an "applicant-friendly" approach, whereby tests and examinations are administered more frequently and closer to the homes of prospective recruits. More broadly, the Army needs to undertake a comprehensive policy review of the recruiting process, including analyses of such areas as propensity to enlist and how it varies by demographic characteristics.[148]

Increasing the number of applicants should enable the Army to better discriminate among the pool of prospective recruits, and therefore to increase soldier quality. The importance of relying on high-quality soldiers has been demonstrated by past research, and could

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[147] See Oken and Asch (1997) for a comprehensive review of the lessons learned on the topic of recruiter management in the U.S. context.

[148] Other areas to explore could include the recruitment of women, the measurement of recruit quality, the role of key "influencers" such as family and friends, and the feasibility of using educational benefits as incentives. Consideration should also be given to other non-economic factors that affect recruiting, such as public attitudes toward military service, support for military spending, and social factors affecting youth choices. In the U.S., the military provides for many service members a sense of community that is lacking in many civilian communities; it would be appropriate to find out whether this also applies in Italy.

even grow in the future as deployments emphasize speed and the ability to maneuver rather than raw--and static--combat power. Since military organizations will in part meet these requirements by delegating responsibility and decision-making authority to the lower ranks, the returns to having soldiers who can effectively handle complex and fast-moving situations could well increase (Warner and Asch, 2000).

- *Second, adopt a more sophisticated approach to personnel management.*

All modern military forces have witnessed ever-greater skill specialization within their workforces over the last few decades. Since developments in future technology are unlikely to stop this trend, compensation and promotion systems will have to be upgraded to better manage such an increase in heterogeneity (Warner and Asch, 2000). In the case of the Italian military, this is hardly a future challenge. In fact, it seems that the Service is not operating with a full institutional understanding of current military labor supply, and of the impact that individual characteristics such as quality and occupational skills affect it. More research in these areas is warranted. Econometric analyses and experiments like the ones performed in the United States over the last three decades should be implemented in the Italian context in order to gauge individual responses to such policy levers as pay, promotion tempo, and occupational assignment. These studies should also produce estimates of how individual behavior (including retention) and productivity vary according individual characteristics such as quality and experience. The potential impact of eventual early exits on the morale and motivation of those who stay will also need to be explored.

With this information in hand, the Italian Army will be able to adopt a more comprehensive approach to personnel management. For instance, special bonuses could be given to those willing to sign up for a hard-to-fill occupational specialty; recruitment goals could be based on quality-focused quotas; and compensation for individuals in terminal grades could at least in part be performance-related. A differentiated approach would also require a greater bureaucratic capacity to collect

and interpret a richer set of data on soldiers, their skills, and their behavior. Such data would also have to be used to construct equally detailed manpower plans by quality, experience mixes, and occupational groups. Finally, this approach would need to be extended to evaluation systems as well as the management of eventual early separations. Personnel in certain occupations or functional areas (e.g., teachers, physicians) could have long careers without causing skill/experience mismatches--the optimal time to leave will not be the same for all personnel.

9.4 RESEARCH AND POLICY CHALLENGES FOR THE FUTURE

This dissertation serves as a preliminary study of the issues and dilemmas that will confront the Italian Army as it transitions to a smaller, all-volunteer force. To be sure, much needs to be better understood before being able to make increasingly specific recommendations. Two principal tracks for further investigation appear most relevant: (1) studies on alternative steady-state force mixes, and (2) experimental/econometric analyses of soldier behavior and its determinants (especially recruitment). These two avenues are tightly related--for instance, finding ways to solve recruitment problems by means other than relying on a very senior steady-state force mix will make any consideration of alternative force mixes more plausible.

Perhaps the most fundamental finding from this research is that the Army cannot be successful in managing the transition with the policies and processes it currently has in place. It is equally clear that the system has to be changed in substantial ways in order to bring performance to acceptable level. Identifying additional areas for improvement, as well as the policy interventions that can bring an effective transformation, will remain a critical research need for years to come.

APPENDIX A. ENLISTMENT SUPPLY MODELS[149]

Military labor supply has usually been estimated econometrically using a log-log model, since with this structural form the coefficients on the dependent variable are all supply elasticities. Formally,

$$\ln H = \beta \ln X \tag{A.1}$$

where the dependent variable H represents high-quality enlistments, and X is a vector of dependent variables. First-generation studies estimated H controlling for relative military pay and youth unemployment. The second-generation studies updated the basic model by incorporating recruiter behavior, which is assumed to be driven by a utility function that depends on the total number of enlistments, quotas for high- and low-quality soldiers, and effort (E). The structural equation takes the following form:

$$\ln H = \lambda \ln L + \beta \ln X + \ln E, \tag{A.2}$$

where L measures low-quality enlistments, and λ gauges the relative difficulty of recruiting high-quality individuals. The variable measuring effort cannot be observed directly, but studies have assumed that effort is a function of recruiter performance relative to the quotas, or:

$$\ln E = \gamma_1 \ln\left(\frac{H}{QH}\right) + \gamma_2 \ln\left(\frac{L}{QL}\right). \tag{A.3}$$

where QH and QL are the quotas for high- and low-quality personnel, respectively. Incorporating equation A3 into equation A2 yields the following expression:

$$\ln H = \alpha_1 \ln L + \alpha_2 \ln X + \alpha_3 \ln Q_H + \alpha_4 \ln Q_L . \tag{A.4}$$

[149] This appendix is based on Asch and Warner's (1995) derivation of structural equations for estimating enlistment supply (pp. 355-56).

Given that L and H are jointly determined, Equation A4 is estimated using a two-step process that adopts the following low-quality recruit equation:

$$\ln L = \theta + \pi_1 \ln X + \pi_2 \ln Q_H + \pi_3 \ln Q_L \qquad \text{(A.5)}$$

Parameter estimates for equations A5 and A4 produce coefficients for A3, which in turn enables the parameters in equation A2 to be specified.

APPENDIX B. THE 1998 ITALIAN HOUSEHOLD INCOME SURVEY

Data set description and use

The civilian earnings tables presented in Chapter 2 are based on data collected by the Bank of Italy's survey of household income and wealth in 1998, which was conducted between February and July 1999. The stratified sample included 7,147 households, and was drawn in two stages (municipalities and households).[150] The summary data presented in this document appears in terms of percentiles of the salary distribution, as opposed to averages. Percentiles are more robust summary statistics, and given the limited sample size and high standard errors associated with the sub-samples used in the analysis, they are likely to be more reliable. A look at percentiles of the income distribution also allows the reader to get a sense for where on such a distribution military salaries are located. The percentile statistics were weighted using a set of analytical weights provided in the data set in order to adjust for the different sampling probabilities of households across Italy. Given the sample frame, the weight coefficient varies according to city size as follows:

$$w_{hi} = \begin{cases} \dfrac{P_h}{P^*_h}\dfrac{P_{hi}}{n_{hi}} \\ \\ \dfrac{1}{m_h}\dfrac{P_h}{n_{hi}} \end{cases} \qquad \text{(B.1)}$$

where the first expression applies to cities above 40,000 inhabitants, while the second is used for cities with up to 40,000 inhabitants. P_h is the resident population, P^*_h is the population of the cities included in the survey, and m_h is that of the cities in the h^{th}

[150] The primary sampling units (municipalities) were stratified by region and size. Within each stratum, the municipalities in which interviews would be conducted was selected by including all municipalities with a population of more than 40,000 and randomly selecting smaller towns. Households were then selected randomly.

stratum. P_{hi} represents the population of interviewees and n_{hi} is the number of interviewees in the i^{th} city of the h^{th} stratum (Bank of Italy, 2000).

Use

The survey differentiates between several sources of income—including employment income, self-employment income, capital gains, and government transfers. Only employment income was used for comparing civilian to military salaries. To exclude part-time workers, observations with employment income of less than Lit.5m were taken out of the sample. And since salary data dated back to 1998, an average nominal wage estimate was used to make the data current to the beginning of 2000.[151]

Limitations

The data set and approach outlined above suffer from a series of limitations, the most important of which relates to sample size for some of the subgroups considered in the analysis. For instance, the data on the salary distribution of the 17-22-year-old cohort is composed of a mere 180 observations. The standard errors are high, and the results should be interpreted with caution. At the same time, however, the data is used for rough comparison purposes only, and as previously mentioned including statistics on median and other deciles adds robustness to the findings.

The fact that data from 1998 is compared with military salaries that were current in 2000 adds a further complication. Ideally, since real and nominal wage growth varies significantly between sectors, 1998 salaries could be converted in 2000 values using the appropriate "inflator." In the absence of such statistics, the average nominal wage growth was used as a rough approximation. Again, given the rather modest data analysis objectives anticipated for this data set, this "short-cut" was deemed acceptable. Lastly, the Lit.5m cutoff to differentiate between full- and part-time workers is arbitrary, but

[151] The "inflator" was obtained from the Economist Intelligence Unit's Italy Country Profile for 2000. See EIU (2000).

reasonable. Moreover, including the relatively few observations below the Lit.5m floor does not substantially alter the income distribution by deciles, as this summary statistic is robust to outliers.

APPENDIX C. DIAGRAMS OF THE ITALIAN ARMY'S GRADE AND PROMOTION SYSTEMS

Figure C.1 Junior Enlisted Personnel (VFB) progression to the career force grades (VSP)

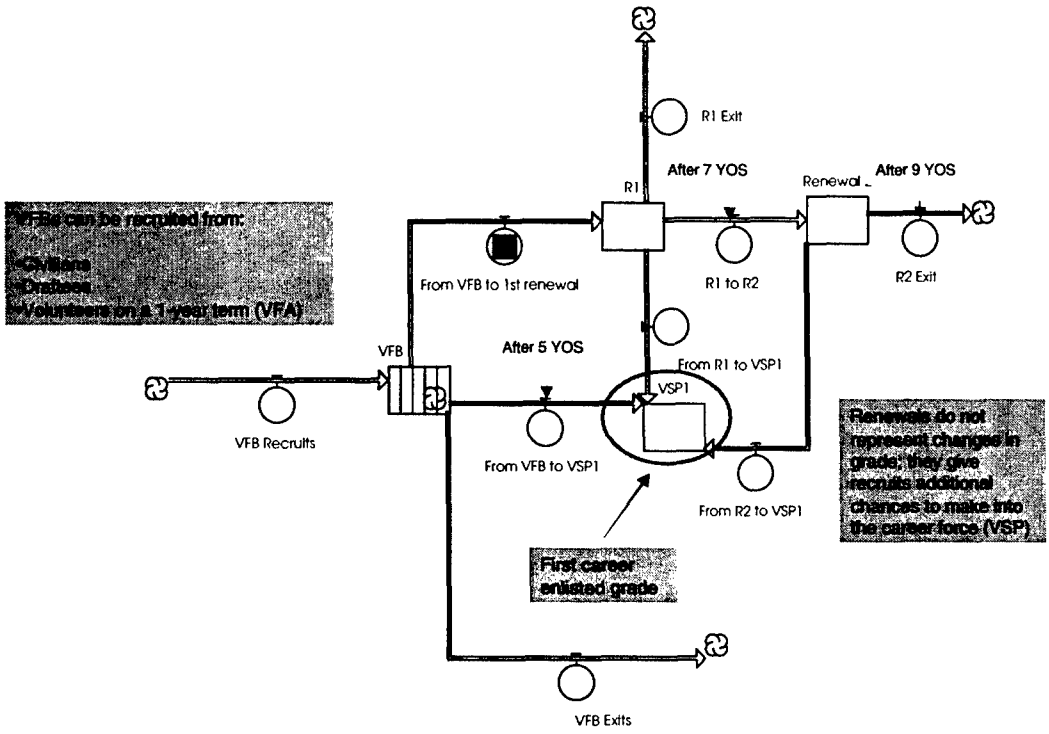


Figure C.2 VSP career progression

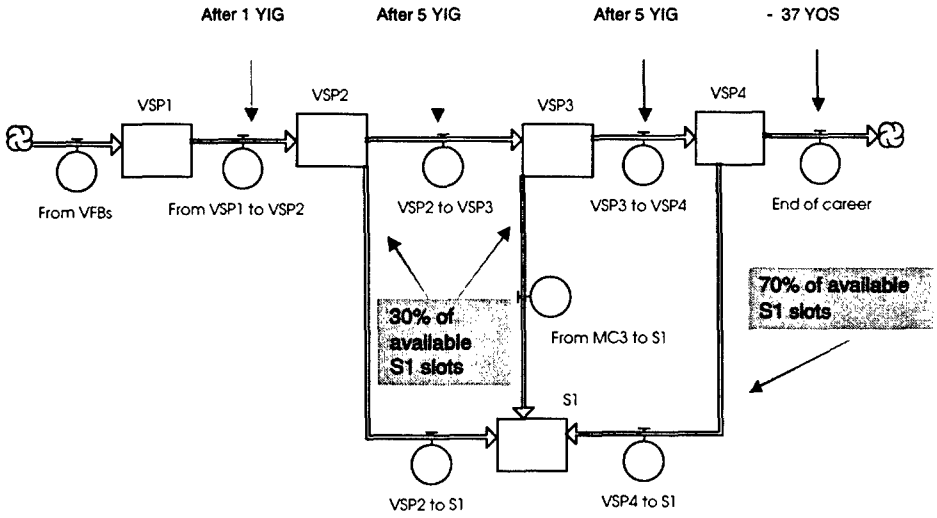


Figure C.3 Sergeants career progression

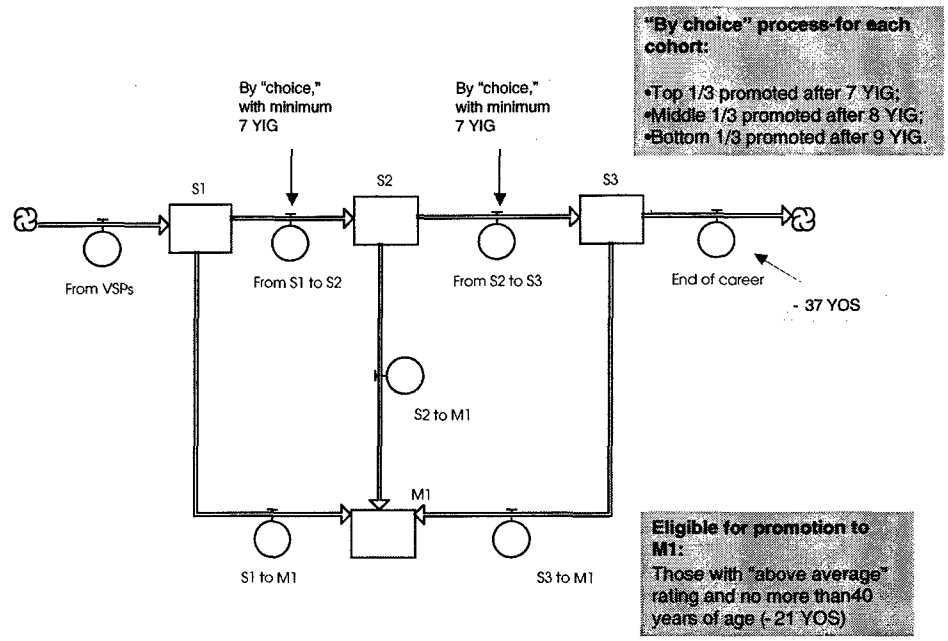
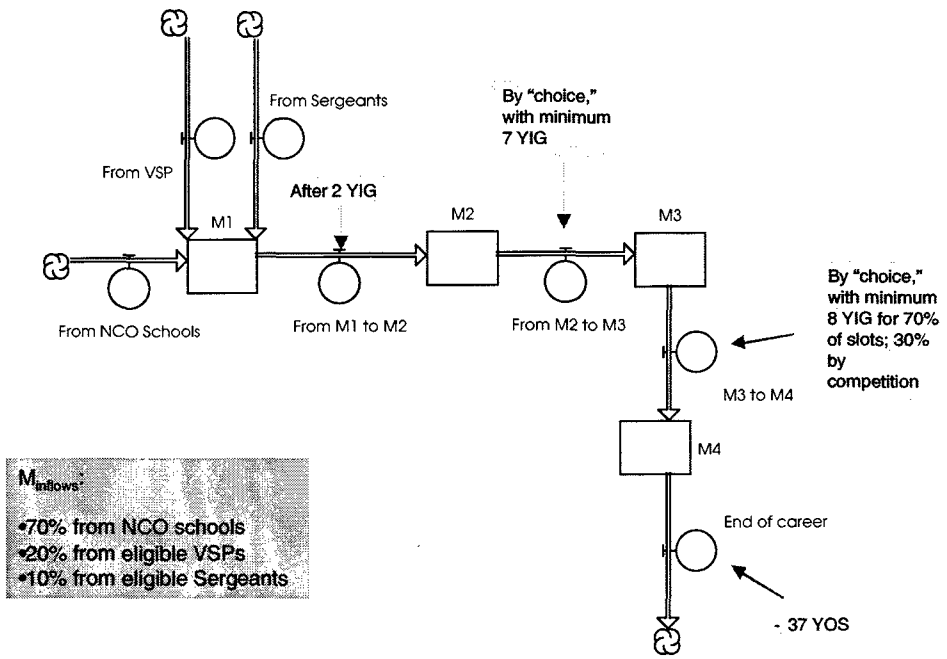


Figure C.4 Marshals career progression



APPENDIX D. MODEL DESCRIPTION AND ASSUMPTIONS

This appendix describes the main features of the two sub-models--including the assumptions that were made to best represent the system within the constraints imposed by ITHINK. The discussion is accompanied by a series of figures that provide a graphical summary of stock-flow relationships across different sectors of the model.[152]

Junior enlisted personnel

The VFB sector contains years-in-grade (YIG) stocks for VFAs, VFBs, and personnel who renewed his/her term of enlistment. There are 5 YIG stocks for VFB--one for the first grade (VFB1) and two each for the remaining grades (VFB2 and VFB3). Not all of these are filled during the early stages of the simulation, since those VFBs who enter service prior to 2003 serve for three instead of five years. There is only one YIG stock for VFAs, matching the 12-month duration of this term. A fraction of VFAs--determined by the model user--is promoted as VFB every year. Promoted VFAs enter the second VFB stock (VFB2A) since their prior experience is taken into account (see Figure D.1).[153] All stocks have an attrition flow associated with them. The values for this and other flows--as well as those of the various policy variables--are discussed in detail in Chapter 7.

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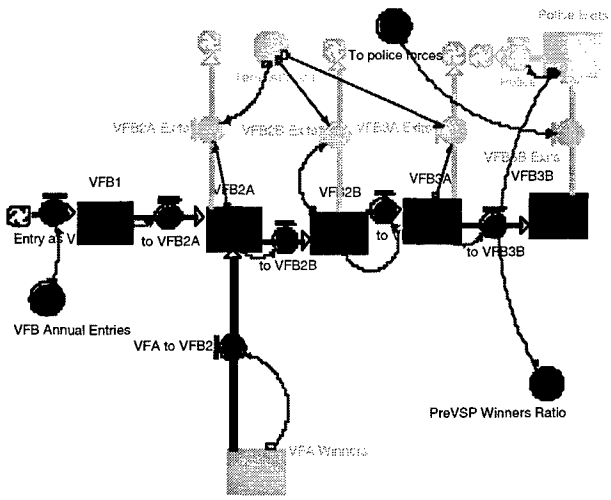
[152] These charts represent the mathematical relationships that regulate the size and timing of flows between stocks. For ease of exposition, such diagrams are somewhat simplified--they correctly reproduce the actual stock and flow structure of the model, but exclude the ITHINK-specific "kludges" that were created to actually run the model (e.g., the DT_Counter variable discussed in Appendix E).

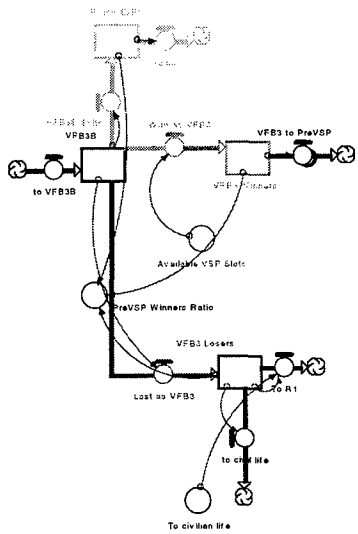
[153] Those VFAs promoted to VFB before 2003 serve for a 3-year term.

Figure D.1 VFB Stocks and flows



The YIG stocks for VFBs do not contain arrays, since in this case there is a one-to-one relationship between each stock and YOS. Career paths begin to diverge after the last YIG stock for VFBs (VFB3B). Beyond this point individuals can (1) leave the force through attrition, (2) join the police forces, (3) win the contest to become VSPs, (4) lose the contest and renew their term (becoming "R1s"), or (5) lose the contest and opt to return to civilian life (see Figure D.2).

Figure D.2 Flows out of VFB3B stock



To properly sort out participants in the VSP promotion contest, two separate stocks connected to the VFB3B stock were created: one for

winners, and the other for losers. Movement into these two stocks takes place as soon as individuals begin their final year as VFB, and both winners and losers are counted as being in the VFB3B stock at the end of the year.[154]

Those who are moved to the winners stock transition to a Pre-VSP1 stock in the next time period; the losers instead either leave the force or move to the first renewal stock (R1). Personnel renewing their term compete every year for a position in the career force with those VFBs on their last year of regular service (VFB3Bs). This takes place for a maximum of four years, as shown in Figure D.3. At the end of the fourth year, unsuccessful "Rs" leave the force.

In the default specification, the model gives individuals who renew the same amount of "access" to the Pre-VSP1 stock enjoyed by VFBs at the end of their regular term--that is all eligible stocks can contribute uniformly to meeting the annual VSP demand. This assumption reflects the spirit of Army regulations, which in fact assign an experience "bonus" to renewing personnel seeking promotion to the VSP ranks.[155]

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[154] The same approach is employed in modeling flows to the Sergeant and Marshals categories, as well as to the M4 grade.

[155] The model also allows users to limit the magnitude of promotions from the renewal stocks in case one wished to give a higher promotion priority to first-term VFBs, or vice-versa.

Figure D.3 VFB Renewals and flows to VSP

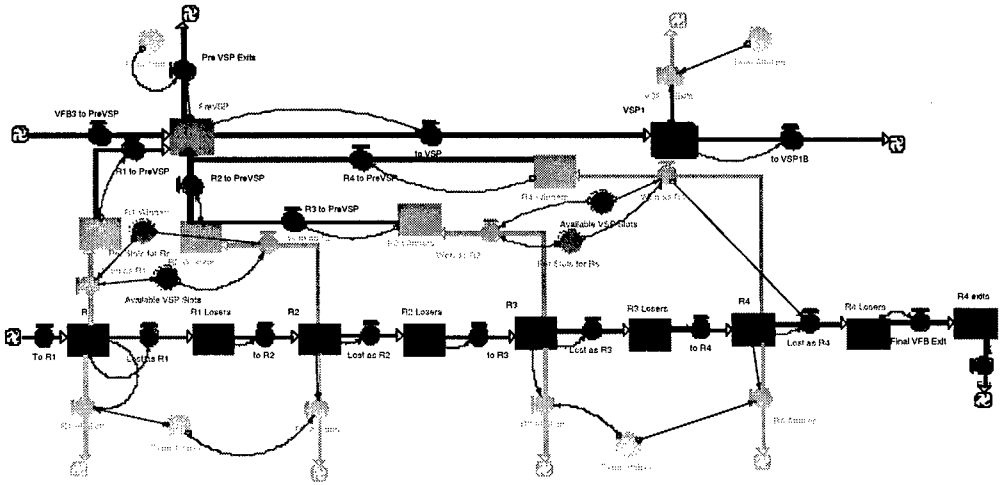
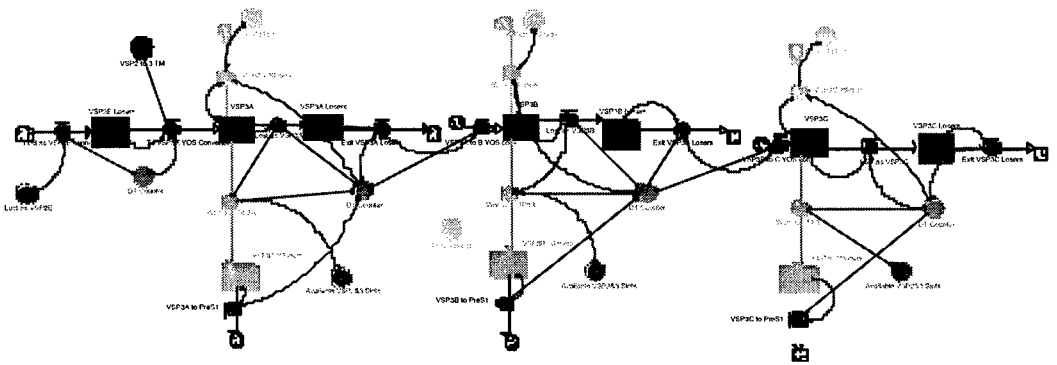


Figure D.4 Section of VSP3 Grade with Sergeant Winners[156]



156 In Figure D.3 (and others that follow) connections between stocks are managed by two flows instead of one. This proved to be the only way ITHINK was able to move elements across one (or two) array(s) and at the same time shift their contents from one stock to the next. In essence, the first flow moves objects from stock A to stock B, while the second calculates the new YOS count before updating B's inventory. The connection between the flows is instantaneous, so no additional time is lost in the process.

VSPs

As mentioned in Chapter 3, there are four grades in the VSP category, including a terminal grade. Following Army promotion rules, outflows to the Sergeant category occur from the first YIG stock of the VSP2 grade. The stocks in the VSP2 and VSP3 grades share a quota of promotions, which in its default setting amounts to 30% of the available Sergeant slots. Since both the VSP2 and VSP3 grades require a 5-year permanence before promotion, 10 YIG stocks can contribute three-tenths of the yearly demand for new Sergeants (and therefore of the flow to the Pre-S1 stock). The remaining 70% of yearly promotions are dedicated to the several YIG stocks in the VPS4 grade. During the first periods of the simulation, the yearly demand for Sergeants is met entirely by those in the VSP2 and VSP3 grades since the VSP4 stocks are empty. Figure D.4 (on the previous page) summarizes graphically a section of the VSP3 grade showing Sergeant contest winners stocks.[157]

While promotions to the Sergeant category are faithfully represented, outflows to the Marshals category were instead simplified. In fact, promotions are restricted to the VSP2 stocks. This simplification excludes from the promotion pool those serving as VSP3s and VSP4s who are in theory eligible. However, it is in line with policy makers' expectations that Marshals promoted vertically should be relatively young (such as with 10 YOS on average), a range most likely found in the VSP2 grade. The impact that this assumption has on model results is limited by the fact that the size of vertical flows to the

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[157] Year-in-grade data was not available for any of the career-force categories. The YIG distribution for each grade was therefore estimated by spreading the quantity of personnel in that grade evenly over the conceivable YIG range. Therefore, if at the beginning of simulation there are members of the VSP3 grade that, because of their YOS, could only have been in the grade for no more than three years, then the total quantity of VSP3s is divided by three. In the absence of better data, this proved to be a conservative and reasonable assumption. Moreover, the conceivable age range for the newer categories of VSP and Sergeant at the beginning of the simulation is relatively narrow--thereby limiting the potential error associated with this approach. The initial YIG distribution of M4 is not relevant since individuals in this grade do not have additional promotion opportunities.

Marshals category remains reduced under the vast majority of feasible scenarios (see Chapters 7 and 8).[158]

Early retirement flows appear for a number of YIG stocks in the VSP4 grade. Retirement probability is a function of YOS; retirement flows are determined by multiplying the retirement probability for each element of an array by the size of that array element in a given stock. The first YIG stock with the early retirement outflow is identified by calculating minimum number of years one could conceivably spend in that grade before retirement.

Sergeants

Sergeants progress through the ranks as described in Chapter 3; those VSPs who transition to the Pre-S1 stock are subsequently moved to the S1A stock, from where they begin their NCO career.[159] Transition to the second and third grades of this category takes place "by choice" (see Figure D.5 for a graphical representation).[160]

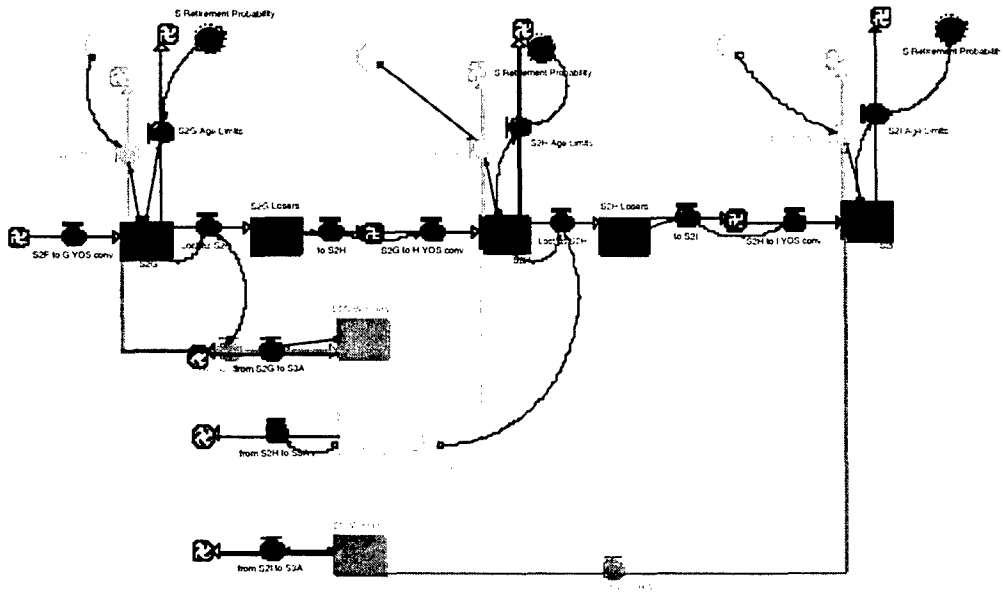
---

[158] The formal requirement for vertical promotion to the Marshals category is a high-school diploma and less than 20 years of service. The limitations associated with this assumption need to be balanced with the significant simplification of the model's architecture, file size and ease of management.

[159] A special series of YIG and arrays was created to account for the fact that currently the Sergeant category is populated with unusually young cohorts, created prior to the passage of the new law. Once these relatively young Sergeants reach the normal age range for the category, the special stocks are merged with the regular YIG stocks.

[160] After seven YOS in the grade, the top one-third of the eligible cohort (c_o) is promoted. The remaining soldiers are evaluated for a second time in t+1. The upper half of these is promoted in t+1, with a class rank below those from the next cohort (c_1) who are promoted in their first year of eligibility. The lower half is instead promoted in t+2, with a class rank that is below those from the cohort c_1 who are promoted after the second review.

Figure D.5 "By choice" promotion system in Sergeants

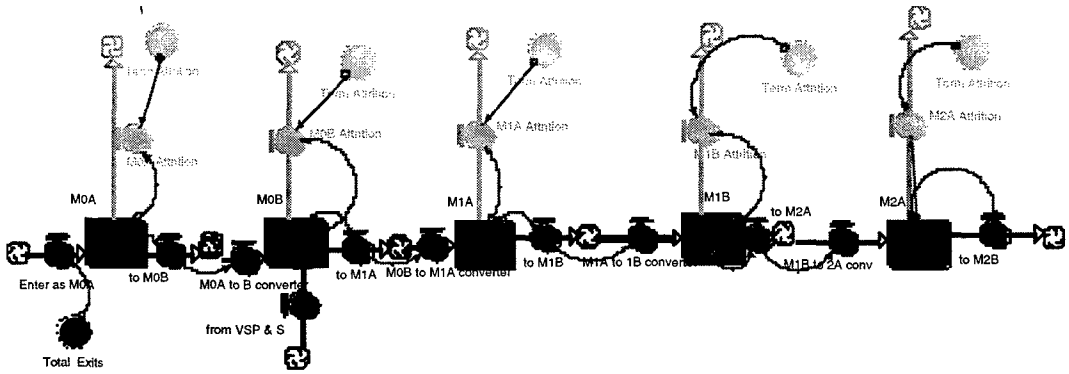


Given that relatively experienced VSPs can be promoted to Sergeant, retirement flows were introduced in the second grade (S2). As in the case of VSPs, Sergeant promotions into Marshals are restricted to those in relatively "young" YIG stocks (e.g., roughly 10 YOS).

Marshals

Marshal inflows take place through lateral recruitment and vertical promotion from the VSP and Sergeant ranks. Both lateral and vertical entrants begin their Marshal career in a training grade (M0), which represents time spent at the NCO academy. Lateral entrants stay in the M0 grade for two years, while former VPSs and Sergeants transition to the first real Marshal grade (M1) after 1 year (see Figure D.6). This reflects the assumption that experienced entrants receive a shorter training course.

Figure D.6 Lateral and vertical entrants in the Marshals sub-model

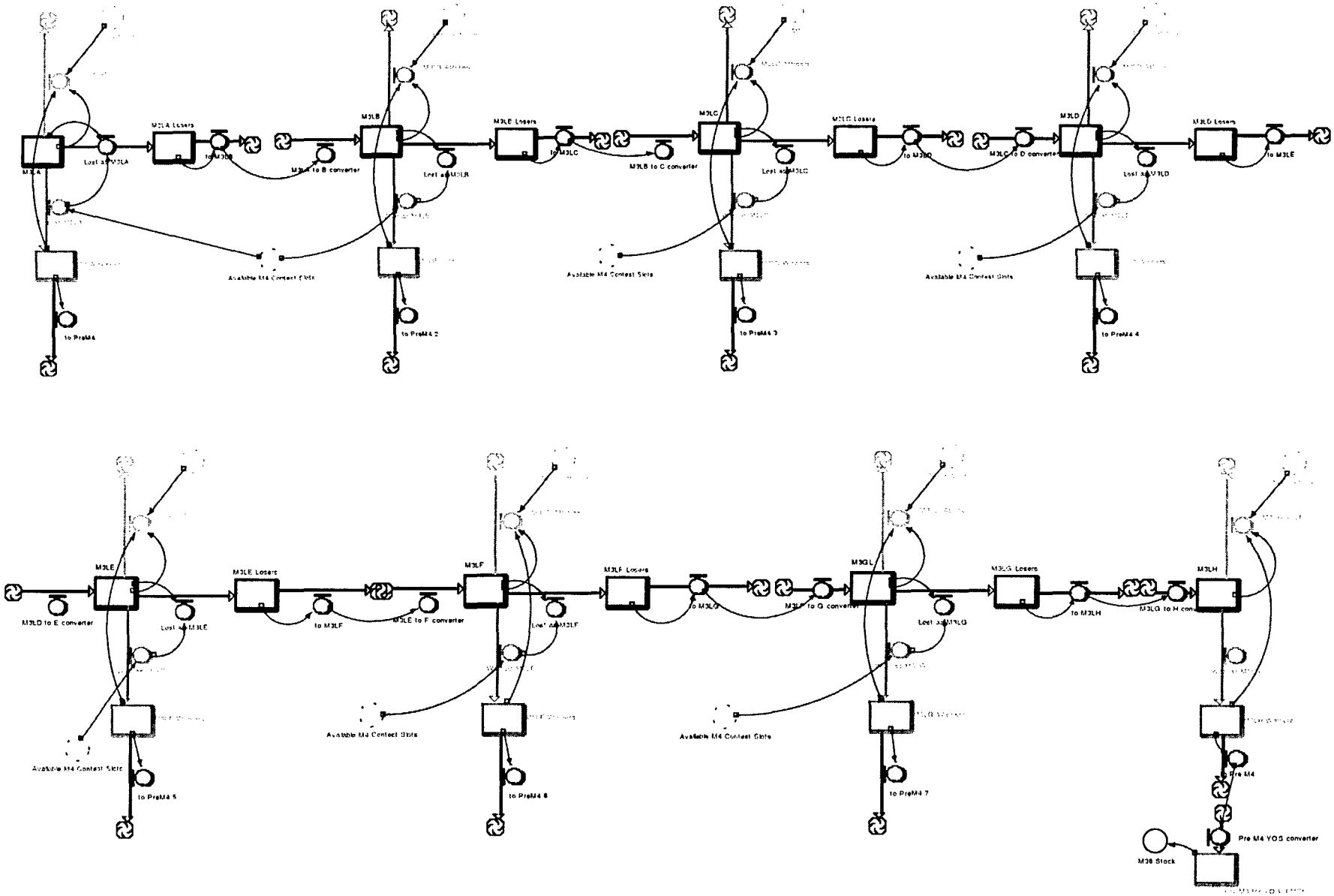


All lateral inflows are assumed to consist of individuals with 11 years of service (10 plus the one year spent in the pre-M stock); this assumption matches the one made for the VSP and Sergeants promotion flows. Such approximation greatly facilitates the operation of the model, and does not lead to results that are significantly at variance with those that could have been obtained with a more realistic (and complicated) representation.

The flows from the M1 to M4 grades replicate the patterns described in Chapter 3. Promotion from M1 to M2 is automatic and occurs after two years in the grade. Promotion from M2 to M3 takes place through the "by choice" system outlined for Sergeants in Figure D.5. Movements from M3 to M4 instead follow a unique procedure--some of the available slots are allocated by contest to those who have spent no more than 7 years in the M3 grade, while the remainder is dedicated to those who have reached the eighth year in grade (see Figure D.7).[161]

[161] In theory, individuals with more than 8 years in the M3 grade could be promoted to M4. However, the simplifying assumption that those M3s who fail to be promoted to M4 before or on the eighth year are no longer eligible reflects the expectation that only few individuals in that position will actually be able to secure promotion.

Figure D.7 M3 promotion flows to M4



APPENDIX E. DESCRIPTION OF MODEL MECHANICS

This appendix explores in greater detail some of the modeling choices and mechanics described in Chapter 6. Specifically, it provides further documentation on the array structure employed, and the decision rules guiding contest-related promotion flows.

Arrays

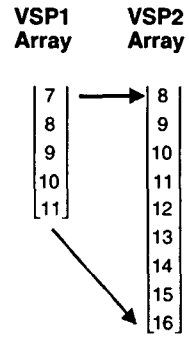
In theory, the entire simulation could record YOS movements from one stock to the next using a single array. In practice, however, this was not feasible. Creating a unique array with 37 elements (as many as the maximum years of service before retirement) proved impossible: ITHINK models featuring large arrays and correspondingly large transition matrices are extremely computing-intensive and require disproportionate amounts of storage space.[162]

To address this problem, smaller arrays were created--in most cases one per grade. These encompass the entire YOS range that could conceivably be found in that grade. The array size for a given grade depends on the size of arrays from more junior grades that are linked to it, as well as the maximum number of years a soldier could stay in that grade. For instance, assume individuals from the VSP1 grade (which only requires one year in grade before promotion) being promoted as VPS2s can have between 7 and 11 years of service. Assume further that the VSP2 grade takes 5 years to complete. As shown in Figure 6.5, this implies that the first element of the VSP2 grade array needs be YOS8 (no one could have 7 or less YOS), and that the last element needs to be YOS16 (no one could stay in the grade beyond 16 YOS).

---

[162] In fact, the ITHINK platform proved to be inefficient at handling arrays. The software program does not allow for easy construction of transition matrices (each transition probability has to be specified using a series of equations), and large matrices and array sizes create giant program files and turn model operation into an extremely slow process.

Figure E.1 Establishing array sizes



In general, the range for grade *i* can be summarized in equation E.1:

$$ArrayRange_i = [YOS_y, ..., YOS_o + MaxYears_i] \quad \text{(E.1)}$$

where YOS_y is represents the years of service of the youngest possible entrant, YOS_o represents the YOS of the oldest possible entrant, and $MaxYears_i$ specifies the maximum number of years that can be spent in year *i*.[163]

The specific arrays used and their respective names are summarized in Table E.1 below. This table shows that there are three exceptions to the one-array-per-grade rule: (1) the VFB category, which only requires array use for those who moved beyond the first 3- or 5-year term; (2) the S1 and S2 grades, for which a special array (SYOSAlt) was created to keep track of the YOS progression of unusually young cohorts during the first years of the simulation; and (3) the M3 grade, where three arrays were created in order to limit a ballooning file size.

---

[163] Promotions through competition entail an extra year spent in the grade one occupied when he/she competed. This is factored into the calculation of the number of YIG stocks for each grade, and therefore in the sizes of arrays. For each non-terminal grade (e.g., VSP2s and VSP3s) that in theory could produce a promotion contest winner, an extra YIG stock was created.

Table E.1 Arrays used in the model and their respective sizes

Array Name	Range of array elements
VFBYOS	YOS4 to YOS10
VSP1YOS	YOS5 to YOS12
VSP2YOS	YOS6 to YOS18
VSP3YOS	YOS11 to YOS23
VSP4YOS	YOS16 to YOS37
SYOS	YOS8 to YOS37
SYOSAlt	YOS4 to YOS10
M0&1&2YOS	YOS1 to YOS22
M3YOS	YOS12 to YOS31
M3YOS2	YOS20 to YOS37
M3YOS3	YOS31 to YOS37
M4YOS	YOS14 to YOS37

Multiple flows

The basic challenge for this promotion mechanism is to devise a procedure that allocates promotion flows from multiple stocks into another stock, under the constraint that

$$\Sigma inflows_{stockD}=X \qquad (E.2)$$

where X is a quota specified by the Army.

Solving this with the use of logical statements (IF…THEN...ELSE) can be overwhelming, since in some situations the number of YIG stocks involved in the multiple flows are very large.[164] A more "emergent" and simple solution involves calculating inflows from A, B, and C as fractions of a time period (delta time, or dt), updating the size of stock D each dt.[165] In essence, each YIG stock contributes to D a fraction of X at each time period. At the moment when D=X, all inflows stop for that time period. Stocks continue sending their allotted quota at each dt until they reach zero quantity; once they do, the remaining stocks still able to contribute increase their relative share of inflows until X, or the maximum quantity lower than X, is sent. By default, the

[164] This is especially true in the terminal grades, where one could conceivably spend twenty years of his/her career. The IF…THEN…ELSE combinations that would have to be considered in these cases are extremely large and therefore unworkable.

[165] These stock names refer to the stylized case first illustrated in section 6.2.

model makes 128 calculations per time period. Such a small delta time implies that each stock sends only a small fraction of what D requires at each calculation; this in turn ensures that flows to D do not under- and/or overshoot X.[166]

In order to make this approach function properly, ITHINK needs to "know" how many calculations are left in a particular time period. To achieve this, a variable (DT_Counter) was created which sums the number of elapsed dts in a period. For instance, if there are 4 calculations per time period, then 1 dt equals 0.25 (1 divided by 4). In this case DT_counter cycles through the following four values: 0.25, 0.5, 0.75, 0. Based on DT_Counter, the following decision rules regulating flows to *D* apply for material in stock *A*:

- *Attrition (priority 1): If DT_Counter=dt, then Attrition*(A/dt), else 0*

This implies that all attrition-related outflows take place *only* at the first calculation (dt), and that the inflow happens instantaneously. The instantaneous flow is ensured by the fact that attrition exits are divided by dt.[167]

- *Flows to D (priority 2): If DT_Counter=1-dt then 0, else (Quota-D)/(1-DT_Counter)*

The expression above instructs the model to incrementally send individuals to D until the next to last dt (0.75 if dt=1/4)--the last flow actually will be counted by the program in last dt (0) of the time period. The promotion flow is divided by "1-DT_Counter" as a way to weigh the outflows by the remaining dts (the fewer the remaining dts, the larger the outflow).

- *Flows to B (priority 3): If DT_Counter= 0 then A/dt else 0*

---

[166] This approach assumes units are divisible. Given the scale of the flows and stock sizes, however, fractional promotions do not sensibly affect overall model output for each time period.

[167] In each dt, the outflow would equal the expected attrition quantity--say L--divided by the number of calculations. It follows that to get an instantaneous flow of L the flow amount for that calculation needs to be L/dt, since (L/dt)/dt = L.

In essence, whatever is left in A after the exits due to attrition and promotion into D are accounted for is taken and moved to B at the end of the period. The material flows from A in the last dt, and appears in B's inventory at the beginning of the next period.

APPENDIX F. "CATCHDATA" EXCEL MACRO

```
Sub RenameWorksheet()
'Renames the worksheet named Data to the name entered in Cell A1.
The name in that cell should be a case name. It creates a new worksheet
named Data to collect the next set of data.  At the end of the routine
it calls the CatchData routine again so that it is ready to collect the
next set of data'
        Sheets("Data").Select
        Range("A1:AF202").Select
        Selection.Copy
        Sheets.Add
            Range("A1").Select
        Selection.PasteSpecial Paste:=xlValues, Operation:=xlNone,
SkipBlanks:= _
            False, Transpose:=False
        ActiveSheet.Name = Cells(3, "B").Value
        CatchData
    End Sub


    Sub CatchData()
    'This routine uses the OnData function to sense when a new set of
data has been sent to the worksheet named Data 'from another linked
application.  When it senses this it calls the RenameWorksheet function
to rename the 'worksheet and then create another worksheet named Data to
collect the next set of data.  Trigger this process by opening the
workbook and choosing the macro, CatchData.'
            'Worksheets("Data").OnEntry = "RenameWorksheet"
            Worksheets("Data").OnData = "RenameWorksheet"
    End Sub
```

APPENDIX G. POLICY LEVER VALUES FOR THE FOUR ALTERNATIVE STRATEGIES

The following sections contain summary tables reporting the values for each policy parameter for each alternative strategy (Strategies 2 to 5). The parameter values for Strategy 1 can be found in Chapter 7; changes from the default setting are indicated in bold letters.

Strategy 2

Table G.1 Strategy 2: Junior enlisted policy levers and values

Policy lever	Default value
VFA hires	14k from 2001 to 2006; 6k 2007- 2010; 0 thereafter
VFB hires	7.3k in 2001; 7.8k in 2002, 6k from 2003 onward
VFA to VFB promotion rate	10%
To police force	33%
To VSP	30%
To Renew	25%
To civilian life	75%
Attrition	1%

Table G.2 Strategy 2: VSP and Sergeant policy levers and values

Policy lever	Default value
Yearly promotion quota to S	1.7% of the sum of all VSP2/3/4s until 2020; =S outflows thereafter
Share of VPS2 and VSP3	30%
Share of VSP4	70%
Yearly quota to M	180 until 2020; 135 thereafter
Share of VSP	70%
Share of S	30%
Attrition: VSP and S	1%
Retirement probability: VSP and S	**25% @ 29 YOS; 50% @ 30; 100% if YOS <=31**

Table G.3 Strategy 2: Marshal policy levers and values

Policy lever	Default value
Yearly demand for new hires up to 2020	**565 until 2020; yearly outflows thereafter**
Lateral entry share	70%
Vertical entry share	30%
Yearly promotion quota to M4	Yearly outflows from M4
Share of M3 (1 to 7 YIG)	30%
Share of M3 (8 YIG)	70%
Attrition	1%
Retirement probability	**From 2001 to 2005:** **25% @ 32 YOS; 50% @ 33; 100% @ 34** **From 2006 onwards:** **25% @ 29 YOS; 50% @ 30; 100% if YOS <=31**

Strategy 3

Table G.4 Strategy 3: Junior enlisted policy levers and values

Policy lever	Default value
VFA hires	14k from 2001 to 2006; 6k 2007- 2010; 0 thereafter
VFB hires	7.3k in 2001; 7.8k in 2002, 6k from 2003 onward
VFA to VFB promotion rate	10%
To police force	33%
To VSP	30%
To Renew	25%
To civilian life	75%
Attrition	1%

Table G.5 Strategy 3: VSP and Sergeant policy levers and values

Policy lever	Default value
Yearly promotion quota to S	1.7% of the sum of all VSP2/3/4s until 2020; =S outflows thereafter
Share of VPS2 and VSP3	30%
Share of VSP4	70%
Yearly quota to M	**180 until 2020, 190 thereafter**
Share of VSP	70%
Share of S	30%
Attrition: VSP and S	1%
Retirement probability: VSP and S	**10% @28 to 34 YOS; 25% @ 35; 50% @ 36; 100% @ 37**

Table G.6 Strategy 3: Marshal policy levers and values

Policy lever	Default value
Yearly demand for new hires up to 2020	**600 until 2020; yearly outflows thereafter**
Lateral entry share	70%
Vertical entry share	30%
Yearly promotion quota to M4	Yearly outflows from M4
Share of M3 (1 to 7 YIG)	30%
Share of M3 (8 YIG)	70%
Attrition	1%
Retirement probability	**From 2001 to 2005:** **25% @ 32 YOS; 50% @ 33; 100% @ 34** **From 2006 onwards:** **10% @28 to 34 YOS; 25% @ 35; 50% @ 36; 100% @ 37**

Strategy 4

Table G.7 Strategy 4: Junior enlisted policy levers and values

Policy lever	Default value
VFA hires	14k from 2001 to 2006; 6k 2007- 2010; 0 thereafter
VFB hires	7.3k in 2001; 7.8k in 2002, 6k from 2003 onward
VFA to VFB promotion rate	10%
To police force	33%
To VSP	30%
To Renew	25%
To civilian life	75%
Attrition	1%

Table G.8 Strategy 4: VSP and Sergeant policy levers and values

Policy lever	Default value
Yearly promotion quota to S	**1.7% of the sum of all VSP2/3/4s up to 2017; 3% until 20201; =S outflows thereafter**
Share of VPS2 and VSP3	30%
Share of VSP4	70%
Yearly quota to M	**650 until 2011, 195 until 2021; 327 thereafter**
Share of VSP	**1 until 2011; 70% thereafter**
Share of S	**1 until 2011; 30% thereafter**
Attrition: VSP and S	1%
Retirement probability: VSP and S	**10% @28 to 34 YOS; 25% @ 35 YOS; 50% @ 36; 100% @ 37**

Table G.9 Strategy 4: Marshal policy levers and values

Policy lever	Default value
Yearly demand for new hires up to 2020	**900 up to 2011; 455 until 2020; yearly outflows thereafter**
Lateral entry share	**Variable**
Vertical entry share	**Variable**
Yearly promotion quota to M4	Yearly outflows from M4
Share of M3 (1 to 7 YIG)	30%
Share of M3 (8 YIG)	70%
Attrition	1%
Retirement probability	**From 2001 to 2005:** **25% @ 32 YOS; 50% @ 33; 100% @ 34** **From 2006 to 2021:** **10% @28 to 30 YOS; 25% @ 31 to 32; 50% @ 33; 100% if YOS <=34** **From 2021 onwards:** **10% @28 to 34 YOS; 25% @ 35; 50% @ 36; 100% @ 37**

Strategy 5

Table G.10 Strategy 5: Junior enlisted policy levers and values

Policy lever	Default value
VFA hires	14k from 2001 to 2006; 6k 2007- 2010; 0 thereafter
VFB hires	7.3k in 2001; 7.8k in 2002, 6k from 2003 onward
VFA to VFB promotion rate	10%
To police force	33%
To VSP	**3%**
To Renew	25%
To civilian life	75%
Attrition	1%

Table G.11 Strategy 5: VSP and Sergeant policy levers and values

Policy lever	Default value
Yearly promotion quota to S	1.7% of the sum of all VSP2/3/4s until 2020; =S outflows thereafter
Share of VPS2 and VSP3	30%
Share of VSP4	70%
Yearly quota to M	**180 until 2020; 200 thereafter**
Share of VSP	70%
Share of S	30%
Attrition: VSP and S	1%
Retirement probability: VSP and S	**From 2003-2011:** **10% from 8 to 10 YOS** **From 2011 onwards: 15% from 28 to 34 YOS; 25% @ 35 YOS; 50% @ 36; 100% @ 37**

Table G.12 Strategy 5: Marshal policy levers and values

Policy lever	Default value
Yearly demand for new hires up to 2020	**600 until 2020; yearly outflows thereafter**
Lateral entry share	70%
Vertical entry share	30%
Yearly promotion quota to M4	Yearly outflows from M4
Share of M3 (1 to 7 YIG)	**10%**
Share of M3 (8 YIG)	**90%**
Attrition	1%
Retirement probability	**From 2001 to 2005:** **25% @ 32 YOS; 50% @ 33; 100% @ 34** **From 2006 to 2021:** **10% from 28 to 34 YOS; 25% @ 35 YOS; 50% @ 36; 100% @ 37** **From 2021 onwards:** **15% from 28 to 32 YOS; 5% from 33 to 34; 25% @ 35; 50% @ 36; 100% @ 37**

APPENDIX H. SUMMARY DATA FOR THE FIVE STRATEGIES

The following figures summarize the quantities of each grade for each year of the simulation. Results are provided for all five strategies; the last two figures contain active-duty and separation cost data.

Figure H.1 Strategy 1: VFA to Sergeants

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
VFA	13860	13860	13860	13860	13860	13860	5940	5940	5940	5940	0	0	0	0	0
VFB1	7300	7800	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000
VFB2	9504	8599	9094	7312	14551	14551	14551	13767	12991	12991	12991	12403	11821	11821	11821
VFB3	7000	9504	8599	9094	0	7167	14333	14333	14333	13565	12796	12796	12796	12220	11644
Renewals	0	583	936	948	992	0	0	597	745	782	791	729	714	710	709
PreVSP1	5445	2287	3105	2809	2971	983	0	2341	2341	2341	2341	2090	2090	2090	2090
Total VFB	29249	28773	27735	26164	24515	28700	34884	37039	36410	35679	34919	34018	33421	32841	32263
VSP1	7227	5391	2264	3074	2781	2941	973	0	2318	2318	2318	2318	2069	2069	2069
VSP2	11878	18808	22912	21823	22859	19749	15612	11324	8925	8440	8173	7715	9004	10786	10626
VSP3	0	0	940	3729	5062	10144	16364	20108	19081	20112	17250	13428	9513	7653	7152
VSP4	0	0	0	0	0	0	0	660	3120	3918	8377	13988	17911	19019	20663
Total VSP	19105	24199	26116	28626	30703	32835	32949	32092	33444	34788	36117	37449	38498	39527	40510
S1	2095	2029	1963	1992	1848	1806	1273	1637	2116	2581	2906	3147	3329	3490	3645
S2	380	376	365	451	817	1148	1926	1810	1717	1700	1789	1821	1816	1595	1536
S3	0	0	8	22	43	79	184	279	351	347	376	526	790	1295	1672
Total S	2475	2405	2336	2465	2708	3033	3383	3727	4185	4629	5071	5494	5935	6380	6853
Grand Total	64689	69237	70046	71115	71786	78428	77156	78797	79979	81036	76108	76962	77854	78747	79627

2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6000	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000
11821	11821	11821	11821	11821	11821	11821	11821	11821	11821	11821	11821	11821	11821	11821
11644	11644	11644	11644	11644	11644	11644	11644	11644	11644	11644	11644	11644	11644	11644
661	649	646	645	645	645	1040	1354	1616	1834	2036	2220	2010	1449	1029
1902	1902	1902	1902	1902	1902	893	905	913	911	912	914	1371	1829	1830
32027	32015	32012	32011	32011	32011	31398	31723	31993	32209	32412	32597	32846	32743	32324
2069	1883	1883	1883	1883	1883	1883	885	896	904	902	903	904	1358	1811
10413	10163	9740	9578	9371	9220	9037	9066	8102	7147	6196	5249	4317	4296	4665
6922	6483	7652	9227	9028	8828	8613	8270	8172	8071	7969	7852	7889	6939	5850
22080	23671	23730	23059	24115	25072	26167	27426	28521	29636	30724	31801	32416	32160	31443
41484	42200	43005	43747	44396	45003	45700	45647	45691	45758	45790	45805	45526	44753	43770
3689	3801	3813	3896	4043	4215	4258	4042	3690	3412	3123	2769	2369	2411	3198
1704	2136	2522	2826	3061	3250	3427	3549	3682	3694	3762	3904	3982	3843	3434
1928	1908	1932	2019	2191	2414	2679	2995	3350	3729	4091	4251	4083	3551	2845
7320	7845	8267	8741	9295	9879	10364	10586	10723	10835	10976	10925	10434	9804	9477
80831	82060	83284	84499	85702	86894	87463	87956	88407	88803	89178	89328	88805	87299	85571

Figure H.2 Strategy 1: Marshals

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
M0	792	838	838	838	838	838	838	838	838	838	838	838	838	838	838
M1	1009	735	923	968	968	968	968	968	968	968	968	968	968	968	968
M2	11104	9253	7673	6384	5616	4969	4439	4039	3748	3665	3667	3738	3752	3752	3752
M3	5383	7175	7960	8973	9505	10192	10791	11286	11507	11485	11077	10565	10071	9418	8590
M4	4555	4587	4947	5217	5567	5684	5518	5046	4634	4385	4487	4570	4577	4547	4480
Total	22843	22588	22340	22380	22494	22652	22554	22177	21695	21341	21037	20680	20207	19524	18628

2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
1100	1100	1100	1100	1100	1100	1318	1344	1034	781	640	596	658	800	1015
1416	1416	1416	1416	1416	1416	1416	1508	1677	1585	1228	944	805	790	900
5456	5456	5456	5456	5456	5456	5456	5456	5456	5546	5711	5709	5522	5241	4921
5077	4978	5085	5133	5120	5101	5053	5042	5116	5386	5741	6116	6517	6864	7131
3117	2986	2619	2306	2138	2111	2203	2474	2759	2908	2971	2924	2787	2573	2389
16165	15936	15676	15410	15230	15185	15446	15823	16042	16205	16291	16288	16287	16267	16357

Figure H.3 Strategy 2: VFA to Sergeants

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
VFA	13860	13860	13860	13860	13860	13860	5940	5940	5940	5940	0	0	0	0	0
VFB1	7300	7800	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000
VFB2	9504	8599	9094	7312	14551	14551	14551	13767	12991	12991	12991	12403	11821	11821	11821
VFB3	7000	9504	8599	9094	0	7167	14333	14333	14333	13565	12796	12796	12796	12220	11644
Renewals	0	583	936	948	992	0	0	597	745	782	791	729	714	710	709
PreVSP1	5445	2287	3105	2809	2971	983	0	2341	2341	2341	2341	2090	2090	2090	2090
Total VFB	29249	28773	27735	26164	24515	28700	34884	37039	36410	35679	34919	34018	33421	32841	32263
VSP1	7227	5391	2264	3074	2781	2941	973	0	2318	2318	2318	2318	2069	2069	2069
VSP2	11878	18784	22912	21823	22859	19749	15612	11325	8965	8465	8200	7741	9017	10777	10638
VSP3	0	0	896	3664	4978	10040	16241	20008	18982	20008	17140	13313	9398	7546	7030
VSP4	0	0	0	0	0	0	0	618	3060	3841	8282	13878	17784	18876	20500
Total VSP	19105	24175	26072	28561	30618	32731	32826	31951	33324	34632	35941	37249	38269	39269	40238
S1	2095	2029	1952	1983	1838	1796	1262	1605	2031	2499	2818	3057	3277	3457	3623
S2	380	376	365	441	798	1119	1889	1773	1681	1665	1749	1768	1734	1493	1421
S3	0	0	8	22	43	79	184	279	351	347	373	517	772	1269	1641
Total S	2475	2405	2325	2445	2679	2995	3336	3658	4063	4511	4940	5343	5782	6219	6685
Grand Total	64689	69213	69991	71030	71672	78286	76986	78588	79737	80762	75800	76610	77472	78329	79186

2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6000	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000
11821	11821	11821	11821	11821	11821	11821	11821	11821	11821	11821	11821	11821	11821	11821
11644	11644	11644	11644	11644	11644	11644	11644	11644	11644	11644	11644	11644	11644	11644
661	649	646	645	645	645	182	60	28	0	0	490	662	769	811
1902	1902	1902	1902	1902	1902	3754	3786	3792	3870	3844	3805	3600	3344	3280
32027	32015	32012	32011	32011	32011	33400	33309	33283	33334	33308	33759	33726	33577	33555
2069	1883	1883	1883	1883	1883	1883	3716	3748	3754	3831	3806	3767	3564	3310
10436	10187	9789	9603	9419	9243	9069	9087	10916	12721	14459	16260	18072	18185	18089
6800	6360	7536	9099	8914	8703	8521	8183	7981	7707	7333	6936	6871	8560	10285
21898	23470	23424	22849	23907	24885	25564	25994	25106	22612	18437	15110	13654	13059	12391
41203	41900	42632	43434	44123	44714	45037	46981	47750	46793	44060	42111	42364	43369	44075
3689	3786	3847	3849	3916	4084	4116	4082	4221	4967	6402	7651	7853	7900	7881
1550	1988	2368	2670	2927	2982	2810	2374	2076	1881	1749	1713	1700	1586	1502
1894	1875	1897	1970	2111	2249	2273	2097	1628	1141	777	685	563	421	286
7133	7649	8112	8489	8954	9316	9199	8553	7924	7989	8928	10049	10116	9907	9669
80363	81564	82756	83934	85088	86040	87636	88844	88958	88116	86296	85918	86206	86852	87299

H.4 Strategy 2: Marshals

06	2007	2008	2009	2010	2011	2012	2013	2014	2015
00	1100	1100	1100	1100	1100	1100	1100	1100	1100
16	1416	1416	1416	1416	1416	1416	1416	1416	1416
92	5276	5088	5008	5132	5282	5432	5456	5456	5456
57	9436	9589	9685	9709	8146	6842	5963	5599	5270
46	3440	3166	2612	2117	2337	2694	2896	2962	3076
12	20668	20359	19821	19474	18281	17484	16831	16533	16318

2022	2023	2024	2025	2026	2027	2028	2029	2030
1318	1344	1034	781	640	596	658	800	1015
1416	1508	1677	1585	1228	944	805	790	900
5456	5456	5456	5546	5711	5709	5522	5241	4921
5053	5042	5116	5386	5741	6116	6517	6864	7131
2203	2474	2759	2908	2971	2924	2787	2573	2389
15446	15823	16042	16205	16291	16288	16287	16267	16357

Figure H.5 Strategy 3: VFA to Sergeants

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
VFA	13860	13860	13860	13860	13860	13860	5940	5940	5940	5940	0	0	0	0	0
VFB1	7300	7800	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000
VFB2	9504	8599	9094	7312	14551	14551	14551	13767	12991	12991	12991	12403	11821	11821	11821
VFB3	7000	9504	8599	9094	0	7167	14333	14333	14333	13565	12796	12796	12796	12220	11644
Renewals	0	583	936	948	992	0	0	597	745	782	791	729	714	710	709
PreVSP1	5445	2287	3105	2809	2971	983	0	2341	2341	2341	2341	2090	2090	2090	2090
Total VFB	29249	28773	27735	26164	24515	28700	34884	37039	36410	35679	34919	34018	33421	32841	32263
VSP1	7227	5391	2264	3074	2781	2941	973	0	2318	2318	2318	2318	2069	2069	2069
VSP2	11878	18784	22912	21823	22859	19749	15612	11325	8965	8465	8200	7741	9017	10777	10638
VSP3	0	0	896	3664	4978	10040	16241	20008	18982	20008	17140	13313	9398	7546	7030
VSP4	0	0	0	0	0	0	0	618	3060	3841	8282	13878	17784	18876	20500
Total VSP	19105	24175	26072	28561	30618	32731	32826	31951	33324	34632	35941	37249	38269	39269	40238
S1	2095	2029	1952	1983	1838	1796	1262	1605	2031	2499	2818	3057	3277	3457	3623
S2	380	376	365	441	798	1119	1889	1773	1681	1665	1749	1768	1734	1493	1421
S3	0	0	8	22	43	79	184	279	351	347	373	517	772	1269	1641
Total S	2475	2405	2325	2445	2679	2995	3336	3658	4063	4511	4940	5343	5782	6219	6685
Grand Total	64689	69213	69991	71030	71672	78286	76986	78588	79737	80762	75800	76610	77472	78329	79186

2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6000	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000
11821	11821	11821	11821	11821	11821	11821	11821	11821	11821	11821	11821	11821	11821	11821
11644	11644	11644	11644	11644	11644	11644	11644	11644	11644	11644	11644	11644	11644	11644
661	649	646	645	784	873	590	522	519	449	407	394	394	394	389
1902	1902	1902	1902	1345	1383	2346	2337	2282	2561	2660	2669	2658	2657	2675
32027	32015	32012	32011	31593	31719	32400	32323	32266	32474	32531	32527	32516	32515	32529
2069	1883	1883	1883	1883	1332	1369	2323	2313	2259	2535	2634	2642	2631	2631
10436	10187	9789	9603	9419	9243	8516	8029	8504	8926	9257	10397	11600	11986	12254
6800	6360	7536	9099	8914	8703	8488	8141	8019	7851	7658	6937	6411	6710	7034
21898	23470	23424	22849	23907	24754	25616	26302	26325	25841	25306	24727	23934	23043	21945
41203	41900	42632	43434	44123	44032	43988	44795	45162	44877	44756	44694	44588	44370	43864
3689	3786	3847	3849	3916	4031	4085	3899	3672	3814	4165	4423	4592	4671	5226
1550	1988	2368	2670	2861	2959	2989	2921	2886	2836	2735	2719	2728	2647	2390
1894	1875	1895	1970	2103	2232	2337	2402	2474	2527	2527	2449	2250	1913	1525
7133	7649	8110	8489	8881	9223	9411	9222	9032	9178	9428	9591	9570	9231	9141
80363	81564	82754	83933	84597	84973	85799	86341	86460	86529	86715	86812	86673	86116	85534

Figure H.6 Strategy 3: Marshals

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
M0	891	1006	1006	1006	1006	1006	1006	1006	1006	1006	1006	1006	1006	1006	1006
M1	1009	764	1050	1162	1162	1162	1162	1162	1162	1162	1162	1162	1162	1162	1162
M2	11104	9253	7673	6412	5740	5187	4750	4442	4243	4250	4333	4455	4489	4489	4489
M3	5371	7175	7532	8412	8839	9115	9505	9697	9759	9646	8843	7988	7303	6671	5960
M4	4555	4587	5374	5372	5642	5870	5722	5425	5090	4813	5123	5419	5573	5646	5698
Total	22930	22785	22634	22364	22388	22340	22145	21732	21260	20877	20467	20029	19532	18973	18315

2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
1006	1006	1006	1006	1006	1006	1260	1326	1153	1032	1021	1050	1087	983	831
1162	1162	1162	1162	1162	1162	1162	1237	1454	1490	1304	1194	1186	1224	1223
4489	4489	4489	4489	4489	4489	4489	4489	4489	4563	4775	4882	4908	4906	4924
5139	4503	3921	3694	3640	3677	3717	3736	3790	3871	3941	3934	3990	4038	4092
5697	5539	5377	5141	4849	4567	4393	4337	4301	4210	4121	4080	4103	4199	4325
17492	16698	15954	15492	15146	14900	15020	15125	15186	15165	15162	15141	15275	15350	15395

Figure H.7 Strategy 4: VFA to Sergeants

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
VFA	13860	13860	13860	13860	13860	13860	5940	5940	5940	5940	0	0	0	0	0
VFB1	7300	7800	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000
VFB2	9504	8599	9094	7312	14551	14551	14551	13767	12991	12991	12991	12403	11821	11821	11821
VFB3	7000	9504	8599	9094	0	7167	14333	14333	14333	13565	12796	12796	12796	12220	11644
Renewals	0	583	936	948	992	0	0	597	745	782	791	729	714	710	440
PreVSP1	5445	2287	3105	2809	2971	983	0	2341	2341	2341	2341	2090	2090	2090	3167
Total VFB	29249	28773	27735	26164	24515	28700	34884	37039	36410	35679	34919	34018	33421	32841	33071
VSP1	7227	5391	2264	3074	2781	2941	973	0	2318	2318	2318	2318	2069	2069	2069
VSP2	11878	18297	22912	21832	22840	19714	15579	11305	8914	8475	8201	7740	9031	10785	10662
VSP3	0	0	0	2277	3168	7807	13579	17537	16576	17595	14729	11393	7962	6598	6546
VSP4	0	0	0	0	0	0	0	0	1962	2659	6684	11874	15381	16091	17324
Total VSP	19105	23688	25176	27183	28789	30463	30131	28841	29771	31047	31932	33325	34442	35544	36602
S1	2133	2074	2009	2037	1884	1828	1270	1647	2133	2223	2443	2593	2680	2769	2886
S2	380	415	447	578	987	1361	2182	2064	1957	1912	2005	2011	1975	1703	1568
S3	0	0	8	22	43	79	184	279	363	385	452	643	947	1492	1894
Total S	2514	2488	2464	2637	2915	3268	3637	3990	4452	4519	4901	5248	5602	5964	6348
Grand Total	64727.82	68809.56	69234	69843.95	70079.4	76290.99	74592.09	75810.48	76573.39	77185	71752.25	72591.19	73465.16	74349.15	76020.77

2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6000	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000
11821	11821	11821	11821	11821	11821	11821	11821	11821	11821	11821	11821	11821	11821	11821
11644	11644	11644	11644	11644	11644	11644	11644	11644	11644	11644	11644	11644	11644	11644
349	327	321	320	696	779	870	920	758	418	333	324	328	344	340
2882	2882	2882	2882	1373	1417	1379	1395	1719	2920	2923	2877	2851	2792	2822
32695	32672	32667	32666	31534	31660	31713	31779	31941	32803	32721	32665	32643	32600	32627
3135	2853	2853	2853	2853	1359	1402	1365	1381	1702	2891	2894	2848	2822	2764
10445	11252	11797	12497	13180	13997	12319	10927	9463	8017	6854	8351	9817	11255	12678
6772	6341	7502	8959	8709	8564	9274	9697	10310	10867	11335	9621	8264	6871	5433
18341	20054	20067	19157	19959	21116	22362	23105	23013	22502	21990	22338	22689	22955	22986
38694	40500	42218	43466	44701	45035	45358	45095	44166	43087	43070	43204	43618	43903	43861
2918	3310	3402	3970	4512	4264	3969	3879	4154	4569	4796	4894	5165	5474	5716
1661	1676	1999	2221	2365	2397	2326	2198	2102	2110	2519	2819	2554	2202	2019
2162	2140	2171	2264	2430	2578	2679	2717	2670	2617	2505	2429	2254	1922	1441
6741	7126	7572	8455	9307	9239	8974	8794	8926	9296	9819	10142	9974	9598	9177
78129.89	80298.6	82457.12	84587.01	85541.91	85933.81	86044.73	85667.72	85033.54	85185.77	85610.31	86011.42	86234.58	86100.89	85663.76

Figure H.8 Strategy 4: Marshals

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
M0	1188	1136	1136	1136	1136	1136	1136	1136	1136	1136	1136	686	686	686	686
M1	1009	1225	1801	1750	1750	1750	1750	1750	1750	1750	1750	1750	1305	863	863
M2	11104	9253	7673	6864	6476	6206	6049	6018	6093	6371	6582	6742	6727	6727	6290
M3	5383	7175	8044	8992	9450	9794	9947	10025	10090	10145	9567	8698	7860	7167	6579
M4	4555	4587	4863	4794	4363	4066	3868	3712	3434	2975	2960	3092	3268	3431	3576
Total	23239	23376	23517	23536	23176	22952	22750	22641	22504	22378	21995	20968	19844	18874	17993

2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
686	686	686	686	686	686	610	568	671	846	990	1127	1317	1331	1204
863	863	863	863	863	863	863	853	789	794	959	1170	1359	1564	1723
5857	5429	5005	4585	4169	3758	3486	3352	3352	3341	3279	3274	3375	3576	3860
6362	6264	6258	6463	6642	6764	6600	6757	6723	6597	6338	5956	5553	5036	4511
3625	3630	3574	3297	3084	3441	3920	3845	3697	3563	3464	3349	3318	3507	3764
17393	16871	16386	15894	15443	15511	15479	15374	15233	15141	15030	14875	14922	15014	15062

Figure H.9 Strategy 5: VFA to Sergeants

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
VFA	13860	13860	13860	13860	13860	13860	5940	5940	5940	5940	0	0	0	0	0
VFB1	7300	7800	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000
VFB2	9504	8599	9094	7312	14551	14551	14551	13767	12991	12991	12991	12403	11821	11821	11821
VFB3	7000	9504	8599	9094	0	7167	14333	14333	14333	13565	12796	12796	12796	12220	11644
Renewals	0	427	686	695	727	0	0	438	546	573	579	534	523	520	519
PreVSP1	5445	2911	3952	3576	3781	720	0	2980	2980	2980	2980	2660	2660	2660	2660
Total VFB	29249	29241	28331	26677	25060	28438	34884	37518	36850	36108	35346	34393	33800	33221	32644
VSP1	7227	5391	2881	3912	3540	3744	713	0	2950	2950	2950	2950	2634	2634	2634
VSP2	11878	18784	22346	20655	20941	19081	17212	13898	11016	10323	9964	9364	11508	13778	13595
VSP3	0	0	889	3641	4921	8076	11639	13068	11776	13083	13401	13635	11872	9450	8794
VSP4	0	0	0	0	0	0	0	582	2987	3708	5494	7864	9436	11140	13549
Total VSP	19105	24175	26116	28208	29401	30901	29564	27547	28729	30065	31809	33813	35450	37002	38571
S1	2095	2029	1952	2018	1928	1944	1407	1887	2259	2789	3081	3243	3387	3609	3631
S2	380	376	365	441	798	1119	1889	1773	1681	1665	1782	1852	1871	1628	1684
S3	0	0	8	22	43	79	184	279	351	347	373	517	772	1269	1641
Total S	2475	2405	2325	2480	2769	3143	3480	3940	4291	4801	5235	5613	6030	6506	6956
Grand Total	64689	69681	70633	71225	71090	76341	73868	74945	75810	76914	72390	73819	75281	76729	78171

2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6000	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000
11821	11821	11821	11821	11821	11821	11821	11821	11821	11821	11821	11821	11821	11821	11821
11644	11644	11644	11644	11644	11644	11644	11644	11644	11644	11644	11644	11644	11644	11644
484	475	473	473	472	472	983	1436	708	535	495	480	482	479	481
2421	2421	2421	2421	2421	2421	712	731	2430	2406	2394	2412	2390	2404	2391
32369	32360	32358	32357	32357	32357	31159	31631	32603	32404	32352	32356	32336	32347	32337
2634	2396	2397	2396	2397	2396	2396	705	724	2406	2382	2370	2388	2366	2380
13302	12997	12459	12221	11986	11761	11532	11554	9896	8242	8230	8262	8237	9837	11462
8471	7904	9870	11908	11644	11361	11063	10580	10379	10146	9874	9678	9654	8054	6439
15649	17951	17709	17031	18607	20057	21394	22710	23445	23918	24305	24610	24510	24263	24000
40056	41249	42434	43556	44634	45574	46385	45549	44443	44711	44791	44919	44789	44519	44281
3806	3865	3996	4206	4413	4432	4571	4435	4370	4511	4726	4656	4784	4747	4873
1763	2258	2628	2886	2982	3031	2916	2802	2687	2656	2696	2763	2703	2665	2468
1894	1875	1904	2003	2168	2289	2377	2355	2352	2312	2264	2159	1995	1690	1339
7463	7999	8528	9095	9563	9751	9864	9592	9408	9479	9686	9578	9482	9102	8680
79887	81608	83320	85009	86554	87683	87409	86772	86454	86595	86829	86854	86608	85968	85298

Figure H.10 Strategy 5: Marshals

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
M0	891	1006	1006	1006	1006	1006	1006	1006	1006	1006	1006	1006	1006	1006	1006
M1	1009	764	1050	1162	1162	1162	1162	1162	1162	1162	1162	1162	1162	1162	1162
M2	11104	9253	7673	6412	5740	5187	4750	4442	4243	4250	4333	4455	4489	4489	4489
M3	5383	7175	7986	8867	9322	9687	10152	10391	10481	10516	9997	9375	8819	8218	7507
M4	4284	4076	4278	4234	4565	4792	4613	4352	4117	3828	3929	4018	4040	4060	4101
Total	22670	22274	21992	21681	21794	21834	21683	21353	21009	20761	20426	20015	19515	18934	18264

2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
1006	1006	1006	1006	1006	1006	1297	1363	1150	991	983	1050	1115	1022	882
1162	1162	1162	1162	1162	1162	1162	1249	1494	1523	1291	1149	1152	1229	1257
4489	4489	4489	4489	4489	4489	4489	4489	4489	4574	4814	4926	4934	4904	4915
6659	5840	5079	4751	4610	4586	4563	4542	4547	4528	4496	4422	4436	4444	4479
4124	4155	4190	4075	3887	3619	3490	3479	3520	3540	3539	3542	3579	3678	3774
17439	16651	15925	15482	15153	14861	15001	15121	15199	15155	15123	15088	15216	15277	15308

Figure H.11 Active-Duty Costs (2000 ITL bn)

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Strategy 1	2,330.9	2,482.1	2,584.3	2,745.9	2,835.6	2,895.0	2,882.7	3,023.9	3,106.3	3,190.8	3,045.7	3,039.2	3,211.8	3,359.8	3,365.4
Strategy 2	2,340.2	2,499.7	2,611.6	2,759.1	2,732.2	2,776.3	2,759.9	2,903.2	2,978.3	3,059.7	2,865.2	2,833.2	2,994.7	3,161.0	3,200.9
Strategy 3	2,334.3	2,489.3	2,596.6	2,738.8	2,821.9	2,868.9	2,849.9	2,988.9	3,069.0	3,149.8	2,997.6	2,985.1	3,155.4	3,308.6	3,325.7
Strategy 4	2,348.8	2,496.8	2,634.8	2,755.4	2,796.3	2,813.7	2,774.9	2,937.9	3,012.4	3,080.4	2,906.9	2,858.6	3,000.1	3,137.2	3,154.5
Strategy 5	2,320.3	2,471.3	2,574.2	2,674.4	2,717.6	2,802.9	2,750.1	2,878.7	2,863.0	2,939.9	2,911.3	2,941.4	3,131.4	3,180.3	3,196.5

2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
3,383.1	3,355.1	3,409.8	3,423.5	3,452.9	3,488.7	3,525.9	3,545.0	3,560.6	3,570.9	3,582.5	3,582.5	3,566.4	3,516.1	3,470.2
3,273.1	3,290.5	3,379.1	3,401.6	3,433.6	3,472.4	3,530.7	3,611.0	3,633.2	3,603.6	3,525.0	3,490.7	3,497.3	3,527.4	3,550.0
3,363.1	3,351.3	3,415.0	3,427.7	3,442.1	3,444.2	3,471.4	3,501.8	3,513.6	3,513.1	3,521.3	3,520.4	3,515.8	3,494.8	3,478.4
3,244.2	3,295.1	3,415.6	3,468.8	3,507.4	3,535.5	3,551.3	3,541.9	3,513.7	3,497.1	3,487.0	3,477.4	3,493.7	3,501.5	3,486.1
3,254.6	3,262.3	3,388.7	3,426.0	3,474.8	3,509.1	3,536.5	3,521.0	3,503.4	3,511.1	3,520.1	3,516.9	3,514.9	3,489.2	3,467.9

Figure H.12 Early separation costs (2000 ITL bn)

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Strategy 2	0.0	0.0	0.0	0.0	0.0	274.5	341.8	445.6	539.6	682.5	823.9	755.4	643.2	515.1	447.5
Strategy 3	0.0	0.0	0.0	0.0	0.0	142.6	201.0	234.2	267.5	259.7	261.9	268.3	268.2	280.0	298.5
Strategy 4	0.0	0.0	0.0	0.0	0.0	279.1	288.0	274.8	313.5	367.7	400.8	461.0	478.6	443.2	411.0
Strategy 5	0.0	0.0	36.7	73.4	95.0	209.4	253.9	272.9	300.3	281.4	267.6	265.7	268.9	282.1	299.7

2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
379.0	335.6	280.1	262.4	240.4	346.8	534.1	830.1	1029.9	1050.0	988.3	922.1	1044.2	1204.4	1285.9
285.0	286.5	216.9	191.7	188.2	222.6	225.3	297.6	393.2	442.2	453.3	466.7	518.1	556.3	563.1
318.7	281.0	252.3	252.4	234.1	248.4	205.9	337.5	471.0	554.9	610.3	635.0	636.8	671.2	663.4
285.8	286.5	216.4	191.6	197.2	267.6	294.0	330.5	384.1	399.1	433.6	482.2	532.2	584.2	634.6

APPENDIX I. RESULTS SHEET SCORES

The following three figures summarize the Results Sheet scores for each of the scorecards discussed in Chapter 8.

Figure I.1 VFA to Sergeants scorecard--Results Sheet

			Default		ST Focus		LT Focus		YOS Focus		Prom Focus		TG Focus		Dist Focus	
			Utility	Cost	Utility	Cost	Utility	Cost	Utility	Cost	Utility	Cost	Utility	Cost	Utility	Cost
		Option Name\Wt	1.0		1.0		1.0		1.0		1.0		1.0		1.0	
1		Strategy 1	54.2	0.0	58.2	0.0	50.3	0.0	35.4	0.0	54.4	0.0	42.5	0.0	84.4	0.0
2		Strategy 2	62.2	0.0	59.0	0.0	59.2	0.0	45.6	0.0	48.8	0.0	68.4	0.0	86.1	0.0
3		Strategy 3	71.3	0.0	58.7	0.0	74.0	0.0	64.1	0.0	63.4	0.0	69.7	0.0	87.9	0.0
4		Strategy 4	76.2	0.0	61.0	0.0	79.7	0.0	72.8	0.0	77.0	0.0	71.6	0.0	83.2	0.0
5		Strategy 5	76.2	0.0	65.3	0.0	81.9	0.0	73.6	0.0	68.8	0.0	77.9	0.0	84.6	0.0
		Base Utility	0		0		0		0		0		0		0	

No.		Strategy	Eff. Rank	Agg. Utility	
1		Strategy 1	5	54.18	
2		Strategy 2	4	61.32	
3		Strategy 3	3	69.88	
4		Strategy 4	2	74.50	
5		Strategy 5	1	75.49	

Figure I.2 Marshals scorecard--Results Sheet

			Default		ST Focus		LT Focus		YQS Focus		Prom Focus		IG Focus		DI Focus	
			Utility	Cost	Utility	Cost	Utility	Cost	Utility	Cost	Utility	Cost	Utility	Cost	Utility	Cost
		Option Name\Wt	1.0		1.0		1.0		1.0		1.0		1.0		1.0	
1		Strategy 1	49.3	0.0	45.1	0.0	61.7	0.0	49.3	0.0	40.8	0.0	48.9	0.0	58.0	0.0
2		Strategy 2	66.1	0.0	65.4	0.0	68.2	0.0	63.8	0.0	56.8	0.0	75.2	0.0	68.5	0.0
3		Strategy 3	58.6	0.0	50.8	0.0	82.1	0.0	61.7	0.0	60.5	0.0	52.1	0.0	60.0	0.0
4		Strategy 4	56.2	0.0	49.2	0.0	77.0	0.0	51.1	0.0	45.2	0.0	73.2	0.0	55.2	0.0
5		Strategy 5	62.8	0.0	57.1	0.0	80.1	0.0	62.5	0.0	56.0	0.0	71.1	0.0	61.7	0.0
		Base Utility	0		0		0		0		0		0		0	

No.		Strategy	Eff. Rank	Agg. Utility	
1		Strategy 1	5	50.4	
2		Strategy 2	1	66.3	
3		Strategy 3	3	60.8	
4		Strategy 4	4	58.2	
5		Strategy 5	2	64.5	

Figure I.3 Aggregate scorecard--Results Sheet

			Default		0.2		0.4		0.6		0.8		1.0	
			Utility	Cost	Utility	Cost	Utility	Cost	Utility	Cost	Utility	Cost	Utility	Cost
		Option Name\Wt	1.0		1.0		1.0		1.0		1.0		1.0	
1		Strategy 1	52.5	57346.1	53.3	57346.1	52.8	57346.1	52.3	57346.1	52.0	57346.1	51.7	57346.1
2		Strategy 2	63.5	64452.4	62.9	64452.4	63.3	64452.4	63.7	64452.4	63.9	64452.4	64.1	64452.4
3		Strategy 3	67.1	60887.6	69.2	60887.6	67.7	60887.6	66.5	60887.6	65.6	60887.6	64.9	60887.6
4		Strategy 4	69.5	61556.4	72.8	61556.4	70.5	61556.4	68.7	61556.4	67.3	61556.4	66.2	61556.4
5		Strategy 5	71.8	60301.3	74.0	60301.3	72.4	60301.3	71.2	60301.3	70.3	60301.3	69.5	60301.3
		Base Utility	0		0		0		0		0		0	

No.		Strategy	Eff. Rank	Agg. Utility	CE Rank
1		Strategy 1	5	52.4	5
2		Strategy 2	4	63.6	4
3		Strategy 3	3	66.8	3
4		Strategy 4	2	69.2	2
5		Strategy 5	1	71.5	1

APPENDIX J. SCORECARD RESULTS FROM TARGET VALUE SENSITIVITY ANALYSIS

This appendix contains the scorecard output from the target value sensitivity analysis mentioned in chapter 8. It is divided into two sections: the first documents the results from the less ambitious set of targets, while the second provides those for the more ambitious values.

RESULTS FOR THE LESS AMBITIOUS SET OF TARGETS

Figure J.1 VFA to Sergeants scorecard, less ambitious targets

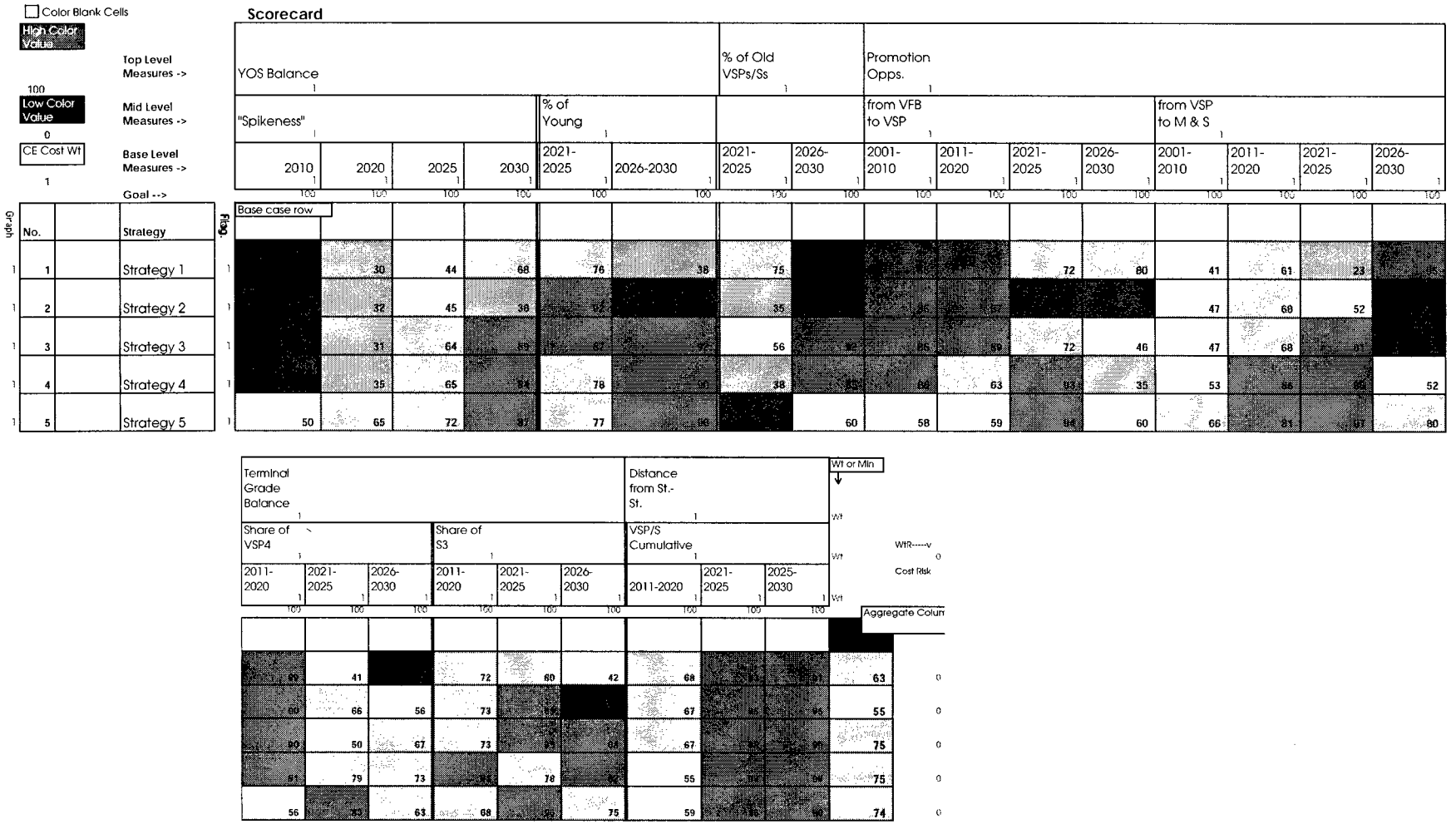


Figure J.2 Marshals scorecard, less ambitious targets

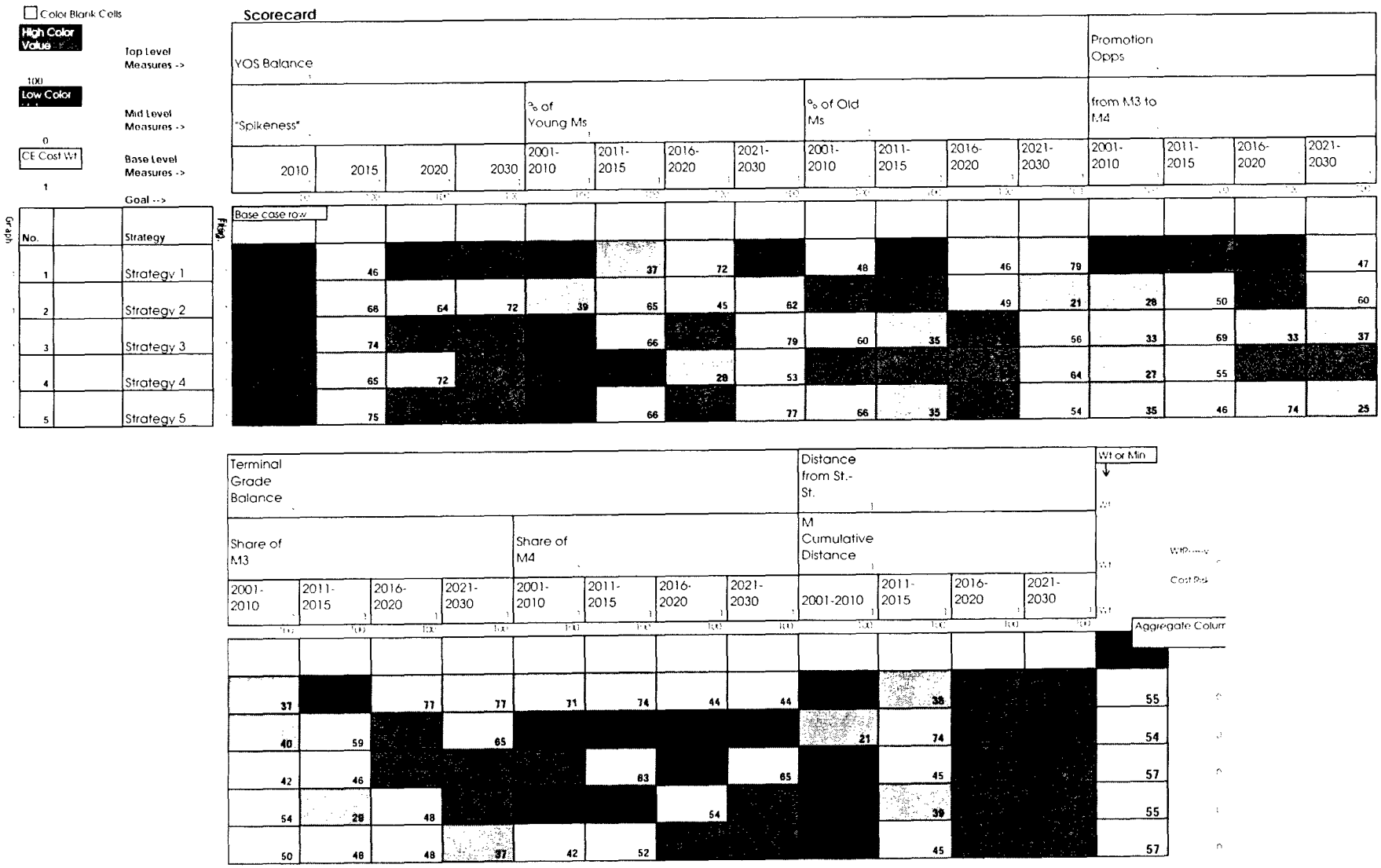


Figure J.3 VFAs to Sergeants: Rank and Result Sheet output, less ambitious targets

	Default	ST Focus	MT Focus	LT Focus	YOS Focus	Prom Focus	TG Focus	Dist Focus
1	Strategy 4	Strategy 5	[illegible]	Strategy 5	[illegible]	Strategy 5	Strategy 4	[illegible]
2	[illegible]	Strategy 4	Strategy 2	Strategy 4	Strategy 4	Strategy 4	[illegible]	Strategy 2
3	Strategy 5	[illegible]	Strategy 5	[illegible]	Strategy 5	[illegible]	Strategy 5	[illegible]
4	[illegible]	Strategy 2	Strategy 4	[illegible]	[illegible]	[illegible]	Strategy 2	Strategy 5
5	Strategy 2	[illegible]	[illegible]	Strategy 2	Strategy 2	Strategy 2	[illegible]	Strategy 4

No.		Strategy	Eff. Rank	Agg. Utility
1		Strategy 1	4	55.75
2		Strategy 2	5	49.62
3		Strategy 3	3	65.04
4		Strategy 4	2	65.87
5		Strategy 5	1	66.43

Figure J.4 Marshals: Rank and Result Sheet output, less ambitious targets

	Default	ST Focus	MT Focus	LT Focus	YOS Focus	Prom Focus	TG Focus	Dist Focus
1	Strategy 3	Strategy 3	[illegible]	Strategy 4	[illegible]	Strategy 4	Strategy 3	Strategy 2
2	[illegible]	[illegible]	Strategy 2	Strategy 3	Strategy 3	[illegible]	[illegible]	[illegible]
3	Strategy 4	Strategy 2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Strategy 3
4	[illegible]	Strategy 4	Strategy 3	[illegible]	Strategy 4	[illegible]	Strategy 4	[illegible]
5	Strategy 2	[illegible]	Strategy 4	Strategy 2	[illegible]	Strategy 3	[illegible]	Strategy 4

No.		Strategy	Eff. Rank	Agg. Utility
1		Strategy 1	4	53.6
2		Strategy 2	5	53.0
3		Strategy 3	1	56.5
4		Strategy 4	3	55.3
5		Strategy 5	2	55.9

Figure J.5 Overall scorecard, less ambitious targets

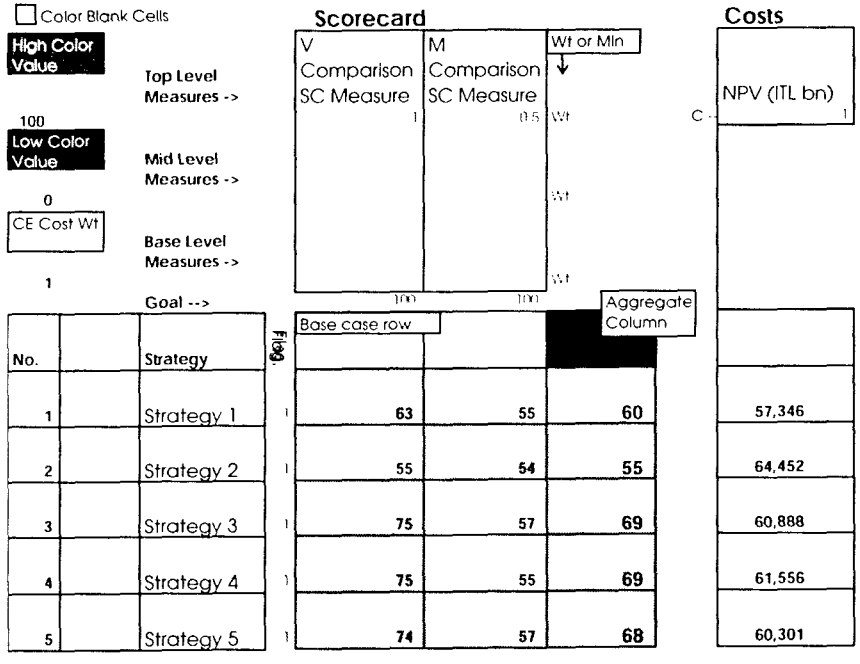


Figure J.6 Overall: Rank Sheet output (by effectiveness), less ambitious targets

	Default	MW:.2	MW:.4	MW:.6	MW:.8	MW:1
1	Strategy 3		Strategy 3	Strategy 3	Strategy 3	Strategy 3
2		Strategy 3				Strategy 5
3	Strategy 5	Strategy 5	Strategy 5	Strategy 5	Strategy 5	
4						
5						

Figure J.7 Overall: Rank Sheet output (by cost-effectiveness), less ambitious targets

	Default	MW:.2	MW:.4	MW:.6	MW:.8	MW:1
1	Strategy 5		Strategy 5	Strategy 5	Strategy 5	Strategy 5
2		Strategy 5				
3	Strategy 4	Strategy 4	Strategy 4	Strategy 4	Strategy 4	Strategy 4
4						
5						

Figure J.8 Overall: Result Sheet output (by cost-effectiveness), less ambitious targets

No.		Strategy	Eff. Rank	Cost Rank	CE Rank	Agg. Utility
1		Strategy 1	4	1	3	60.01
2		Strategy 2	5	5	5	55.07
3		Strategy 3	1	3	1	68.32
4		Strategy 4	2	4	4	68.19
5		Strategy 5	3	2	2	67.99

RESULTS FOR THE MORE AMBITIOUS SET OF TARGETS

Figure J.9 VFA to Sergeants scorecard, more ambitious targets

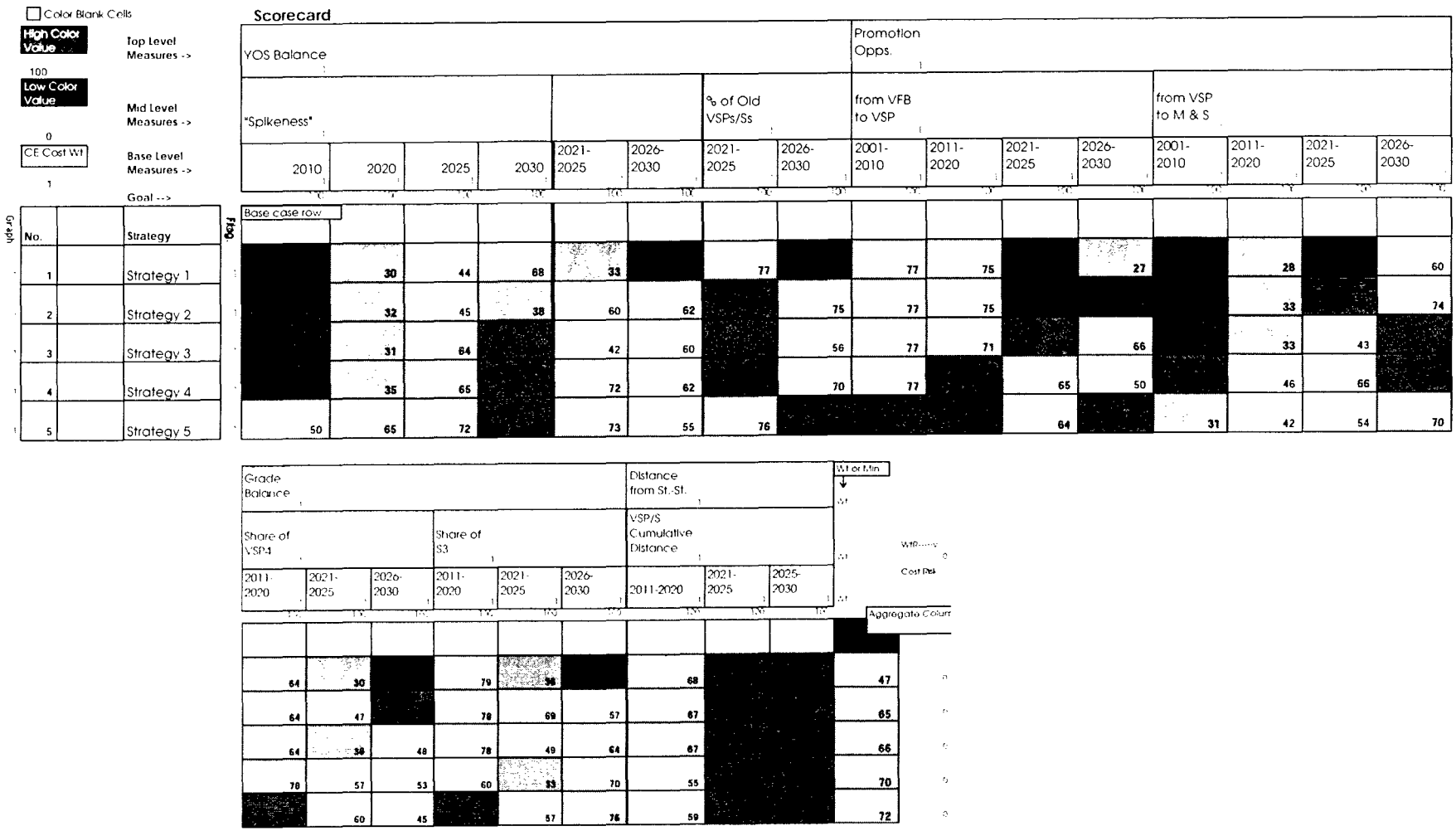


Figure J.10 Marshals scorecard, more ambitious targets

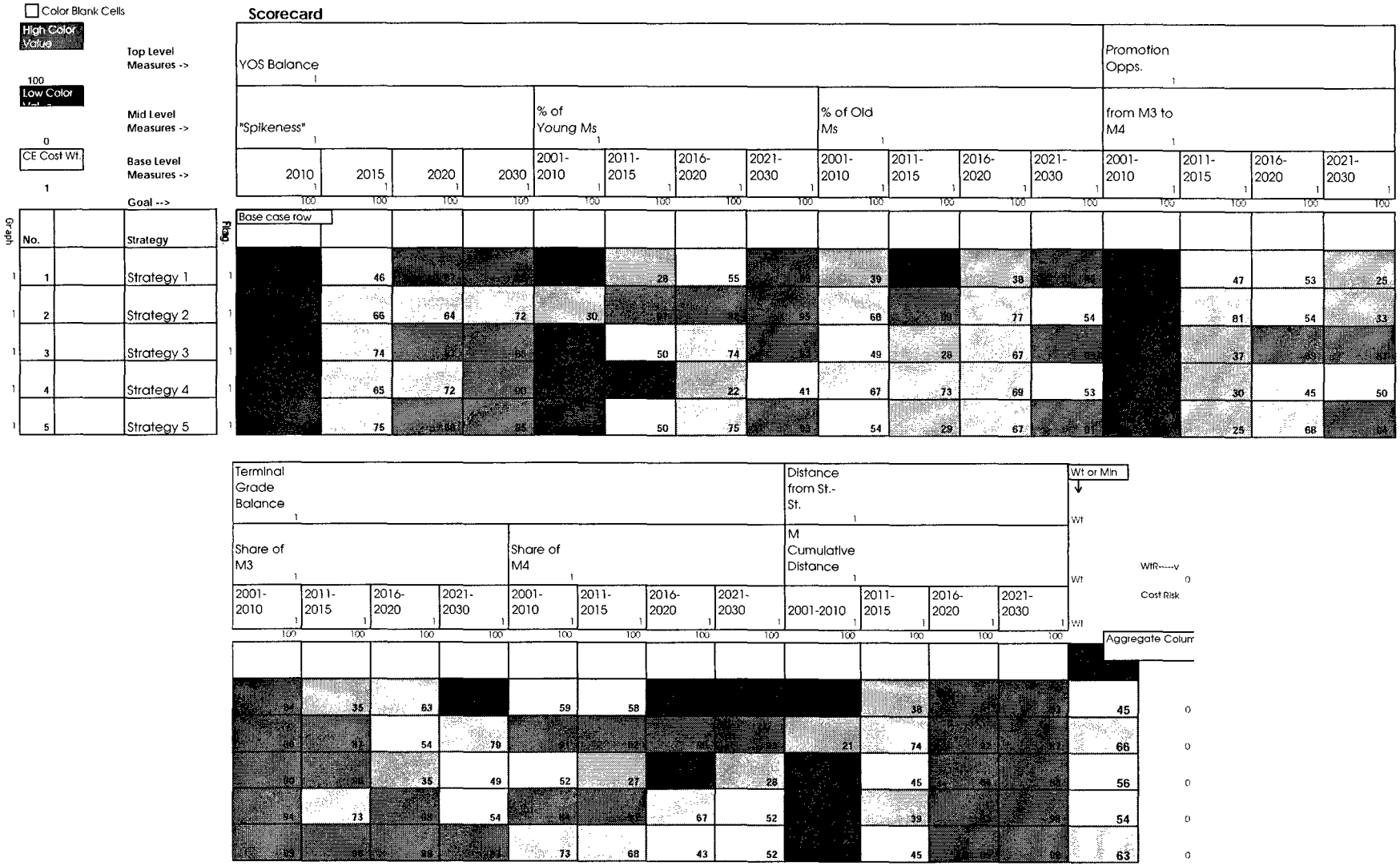


Figure J.11 VFAs to Sergeants: Rank and Result Sheet output, more ambitious targets

	Default	ST Focus	MT Focus	LT Focus	YOS Focus	Prom Focus	TG Focus	Dist Focus
1	Strategy 5	Strategy 5	Strategy 5	Strategy 5	Strategy 5		Strategy 5	Strategy 3
2						Strategy 5		
3	Strategy 3	Strategy 3		Strategy 3		Strategy 3		
4					Strategy 3		Strategy 3	Strategy 5
5			Strategy 3					

No.		Strategy	Eff. Rank	Agg. Utility
1		Strategy 1	5	40.88
2		Strategy 2	4	55.44
3		Strategy 3	3	56.28
4		Strategy 4	2	61.12
5		Strategy 5	1	64.62

Figure J.12 Marshals: Rank and Result Sheet output, more ambitious targets

	Default	ST Focus	MT Focus	LT Focus	YOS Focus	Prom Focus	TG Focus	Dist Focus
1	Strategy 2	Strategy 2	Strategy 2		Strategy 2	Strategy 3	Strategy 2	Strategy 2
2				Strategy 3				
3	Strategy 3			Strategy 2	Strategy 3	Strategy 2		Strategy 3
4		Strategy 3	Strategy 3				Strategy 3	
5								

No.		Strategy	Eff. Rank	Agg. Utility
1		Strategy 1	5	44.11
2		Strategy 2	1	65.08
3		Strategy 3	3	56.02
4		Strategy 4	4	53.06
5		Strategy 5	2	62.59

Figure J.13 Overall scorecard, more ambitious targets

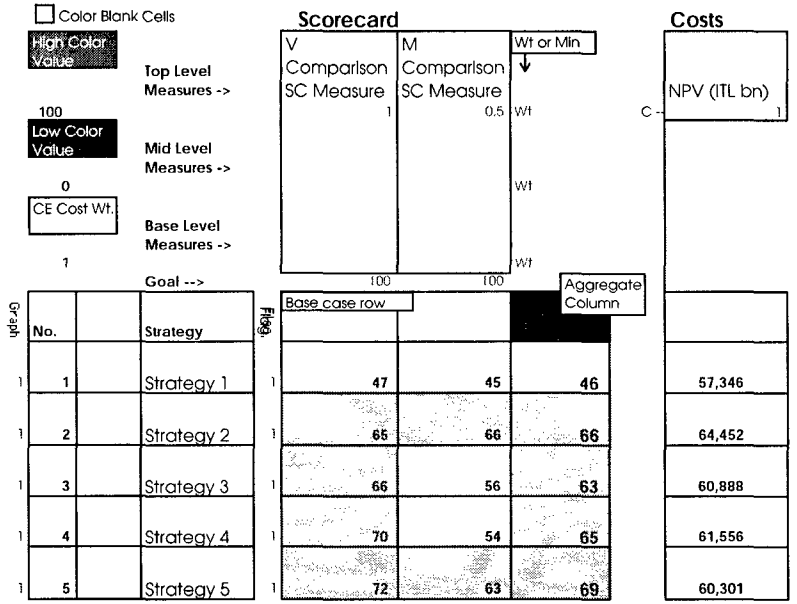


Figure J.14 Overall: Rank Sheet output (by effectiveness), more ambitious targets

	Default	MW:.2	MW:.4	MW:.6	MW:.8	MW:1
1	Strategy 5	Strategy 5	Strategy 5	Strategy 5	Strategy 5	Strategy 5
2	Strategy 2	Strategy 4	Strategy 2	Strategy 2	Strategy 2	Strategy 2
3	Strategy 4	Strategy 2	Strategy 4	Strategy 4	Strategy 4	Strategy 4
4	Strategy 3	Strategy 3	Strategy 3	Strategy 3	Strategy 3	Strategy 3
5	Strategy 1	Strategy 1	Strategy 1	Strategy 1	Strategy 1	Strategy 1

Figure J.15 Overall: Rank Sheet output (by cost-effectiveness), more ambitious targets

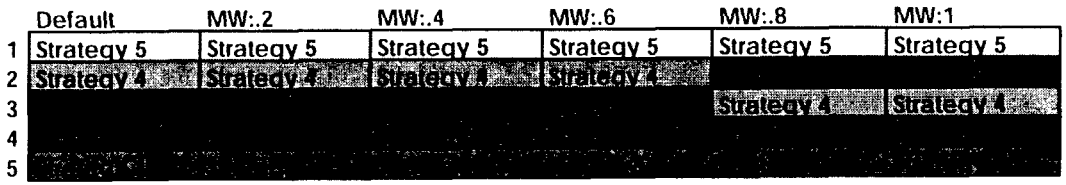


Figure J.16 Overall: Result Sheet output, more ambitious targets

No.		Strategy	Eff. Rank	Cost Rank	CE Rank	Agg. Utility
1		Strategy 1	5	1	5	43.01
2		Strategy 2	2	5	4	62.40
3		Strategy 3	4	3	3	59.15
4		Strategy 4	3	4	2	61.03
5		Strategy 5	1	2	1	65.65

APPENDIX K. DESCRIPTION OF ALTERNATIVE STEADY-STATE STRATEGY

This Appendix contains information on the more junior steady-state strategy discussed in Chapter 9. It is divided into two sections: the first summarizes the basic features of the strategy and the policy lever parameters that were adopted, while the second contains output data on model output for every year of the simulation.

Junior force strategy--policy lever parameters

As summarized in tables K.1 to K.3, this strategy is implemented by raising the post-2003 yearly intakes of VFBs from 6,000 to 10,000. At the end of the first term of enlistment the number of personnel able to transition to the VSP force or to renew as VFB is significantly smaller than in the base case. For those promoted to VSP, however, progression opportunities are higher. In order to prevent vertical promotions to the Marshals force to drop to insignificant levels in the face of deeper downsizing, two-thirds of all available Marshal slots are dedicated to VSPs and Sergeants (and only to VSPs from 2001 to 2011). The share of vertical promotions from 2020 onward is of 50%. The pattern of early separations for VSPs and Sergeants is identical to Strategy 3's; it is instead much more radical in the case of Marshals since individuals begin to leave at their 20th year of service.

Table K.1 "Junior Force" Strategy: Junior enlisted policy levers and values

Policy lever	Default value
VFA hires	14k from 2001 to 2006; 6k 2007- 2010; 0 thereafter
VFB hires	7.3k in 2001; 7.8k in 2002, 10k from 2003 onward
VFA to VFB promotion rate	10%
To police force	33%
To VSP	15%
To Renew	10%
To civilian life	90%
Attrition	1%

Table K.2 "Junior Force" Strategy: VSP and Sergeant policy levers and values

Policy lever	Default value
Yearly promotion quota to S	3% of the sum of all VSP2/3/4s
Share of VPS2 and VSP3	30%
Share of VSP4	70%
Yearly quota to M	180 until 2020; 270 thereafter
Share of VSP	100% until 2011; 70% thereafter
Share of S	0% until 2011; 30% thereafter
Attrition: VSP and S	1%
Retirement probability: VSP and S	10% @28 to 34 YOS; 25% @ 35; 50% @ 36; 100% @ 37

Table K.3: "Junior Force" Strategy: Marshal policy levers and values

Policy lever	Default value
Yearly demand for new hires up to 2020	270 until 2020; yearly outflows thereafter
Lateral entry share	33% until 2020; 50% thereafter
Vertical entry share	66% until 2020; 50% thereafter
Yearly promotion quota to M4	Yearly outflows from M4
Share of M3 (1 to 7 YIG)	10%
Share of M3 (8 YIG)	90%
Attrition	1%
Retirement probability	From 2001 to 2005: 15% @ 20 to 31 YOS; 25% @ 32 YOS; 50% @ 33; 100% @ 34 From 2006 and beyond: 15% @20 to 34 YOS; 25% @ 35; 50% @ 36; 100% @ 37

Model output for the junior force strategy

Figure K.1 Junior force strategy: VFA to Sergeants

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
VFA	13860	13860	13860	13860	13860	13860	5940	5940	5940	5940	0	0	0	0	0
VFB1	7300	7800	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000
VFB2	9504	8599	9094	11272	22432	22432	22432	21647	20871	20871	20871	20283	19701	19701	19701
VFB3	7000	9504	8599	9094	0	11048	22096	22096	22096	21327	20559	20559	20559	19982	19406
Renewals	0	358	522	491	514	0	0	565	621	627	627	588	584	584	584
PreVSP1	5445	1040	1411	1277	1350	509	0	1641	1641	1641	1641	1526	1526	1526	1526
Total VFB	29249	27301	29626	32135	34296	43988	54527	55949	55229	54466	53698	52956	52370	51793	51217
VSP1	7227	5391	1029	1397	1264	1337	504	0	1624	1624	1624	1624	1511	1511	1511
VSP2	11878	18729	22942	20550	19854	15201	9499	4823	3719	4222	4798	5238	6300	7509	7497
VSP3	0	0	756	3402	4512	9296	15193	18957	16756	16227	12024	6892	2778	2264	2783
VSP4	0	0	0	0	0	0	0	334	2544	3137	7221	12472	16066	15782	15665
Total VSP	19105	24120	24728	25349	25630	25834	25195	0	24644	25209	25667	26226	26655	27066	27457
S1	2133	2074	2009	2189	2280	2534	2273	2901	3545	4132	4434	4543	4548	4546	4629
S2	380	415	447	578	987	1361	2182	2064	1957	1912	2146	2387	2638	2655	2753
S3	0	0	8	22	43	79	184	279	363	385	452	643	947	1492	1894
Total S	2514	2488	2464	2788	3311	3975	4639	5243	5865	6428	7033	7573	8133	8693	9276
Grand Total	64728	67769	70678	74132	77096	87657	90302	91246	91677	92043	86397	86755	87158	87553	87950

2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000
19701	19701	19701	19701	19701	19701	19701	19701	19701	19701	19701	19701	19701	19701	19701
19406	19406	19406	19406	19406	19406	19406	19406	19406	19406	19406	19406	19406	19406	19406
554	551	551	551	571	572	578	574	503	428	423	427	421	433	430
1441	1441	1441	1441	1237	1248	1195	1239	1941	2623	2603	2557	2620	2494	2532
51102	51099	51099	51099	50915	50927	50880	50919	51551	52158	52132	52091	52148	52033	52069
1511	1426	1426	1426	1426	1225	1235	1183	1226	1921	2597	2577	2532	2594	2469
7410	7310	7122	7037	6938	6909	6667	6473	6196	5959	6426	7750	9093	10420	11726
3435	3876	4825	5838	5773	5787	5702	5473	5321	5101	4852	4471	4248	3983	3759
15465	15473	14962	14271	14659	15322	15898	15892	15170	14064	13237	12240	11535	10905	9984
27821	28085	28335	28572	28796	29243	29503	29021	27914	27045	27112	27037	27409	27902	27938
4694	4819	4857	4945	5028	4529	4183	4182	4488	4985	5355	5949	6500	6921	7185
3013	3510	3995	4290	4360	4264	4073	3864	3687	3573	3513	3453	2974	2586	2483
2162	2140	2215	2425	2785	3152	3448	3622	3721	3773	3741	3623	3335	2834	2237
9869	10469	11067	11660	12173	11945	11703	11668	11896	12330	12608	13025	12809	12341	11906
88792	89652	90501	91331	91884	92115	92086	91608	91360	91533	91853	92153	92365	92277	91912

Figure K.2 Junior force strategy: Marshals

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
M0	564	356	356	356	356	356	356	356	356	356	356	356	356
M1	1009	764	729	525	525	525	525	525	525	525	525	525	525
M2	11104	9253	7673	6412	5426	4563	3818	3206	2705	2413	2201	2128	2065
M3	5383	7175	7917	8771	9239	9662	9938	10094	10203	10265	9666	8874	8043
M4	3959	3569	3774	3943	3997	3975	3858	3653	3428	3164	3294	3378	3351
Total	22018	21117	20449	20006	19542	19080	18494	17834	17218	16724	16041	15259	14340

2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
356	356	356	356	356	356	356	356	876	1092	941	799	752	733	722	663
525	525	525	525	525	525	525	525	525	738	1206	1364	1172	1031	976	957
2065	2065	2065	2065	2065	2065	2065	2065	2065	2065	2065	2274	2732	3092	3353	3568
4964	3920	3005	2488	2149	1993	1908	1906	1913	1918	1923	1921	1943	1963		
3375	3458	3493	3352	3118	2790	2478	2193	1988	1791	1615	1452	1326	1260		
11285	10323	9443	8786	8213	7729	7852	7994	8113	8145	8194	8228	8322	8410		

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